Je 19'08

$4.00 per Year

JUNE 11, 1908.

Price 10 Cents

CITY OF DETROIT
PUBLIC LIBRARY

AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY,

Vol. 31. 505 PEARL STREET, NEW YORK. No. 24.

Index to Advertisers and Classified Index Following Reading Matter.

NOVO STEEL

Always reliable and safe to use. For expensive tools NOVO is on TOP of all High Speed Steels.

INTRA STEEL

Between High Speed and Carbon Tool Steel.

Remarkable cutting qualities, extreme toughness, easy to handle, water hardening.

Ask to have your tools made of INTRA Steel. Price same as Carbon Tool Steel.

HERMANN BOKER & CO.

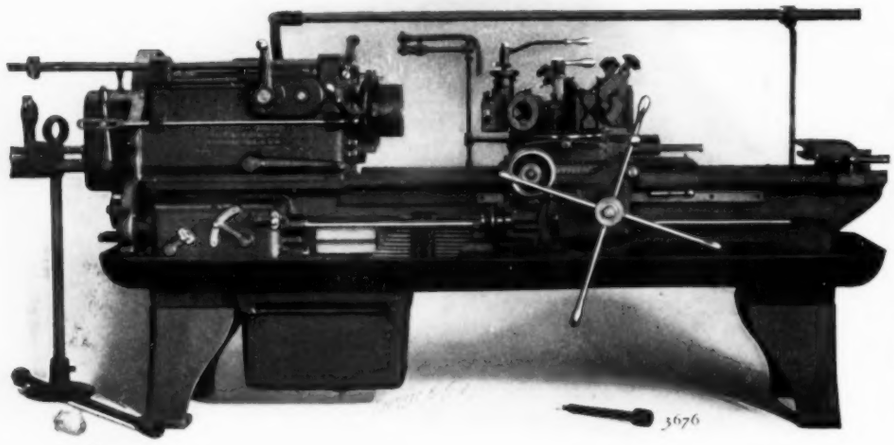
101-103 DUANE ST., NEW YORK.

WESTERN SALES OFFICE AND WAREHOUSE
57-63 NORTH DESPLAINES ST., — CHICAGO, ILL.

THE OPEN TURRET LATHE

WITH CROSS-SLIDING TURRET

Equally suitable for work on Bars, Forgings and Castings



Points of superiority.

The *open* turret gives tools a *rigid backing* as well as a solid seat.

Single drive with sixteen changes of speed *while running.*

Stationary head-stock—the most practical and economical arrangement for belt or motor drive.

Work is held in head-stock, which is *bolted solid to the bed,* and tool is brought to the work with a rigid, yet sensitive tool carrier.

30 per cent. *heavier* than any turret lathe of its size.

Horizontal locking bolt, directly under cutting tool, obviates all tendency to force turret from its seat.

Turret is mounted on a *cross slide* with a *broad base* and a *narrow guide* and can always be returned to absolute central position by positive stop, either by hand or power.

Write for complete Catalog "The Open Turret Lathe"

PRATT & WHITNEY COMPANY,

HARTFORD, CONN., U.S.A.

OFFICES—Trinity Building, 111 Broadway, New York. Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 616 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. Agents: California, Nevada and Arizona, Harron Rickard & McCone, 436 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. Japan, F. W. Horne, 70 C Yokohama.

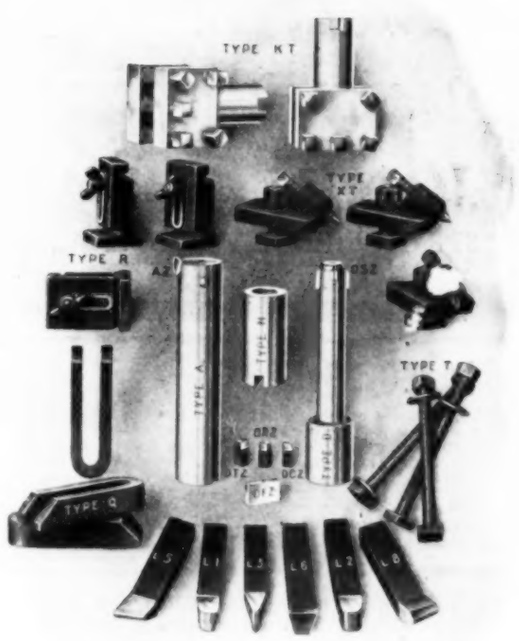
BULLARD

Tool Equipments
for
Boring Mills

will increase the productive capacity of any mill and at the same time secure greatest possible accuracy of output.

Without the proper equipment of tools a boring mill cannot be expected to do its best work, and therein lies the value of these Bullard outfits. They have been developed by experts, after years of experimenting in this one line, and the results they obtain are procurable in no other way.

Our new booklet, just issued, describes them in detail.



Send for Catalog AE-14

The Bullard Machine Tool Co.
BRIDGEPORT, CONN., U.S.A.

Marshall & Huschart Machinery Co., Chicago, Ill. The Motch & Merryweather Machinery Co., Cleveland, O. Chas. G. Smith Co., Pittsburg, Pa. C. H. Wood Co., Syracuse, N. Y. Pacific Tool & Supply Co., 556 Howard Street, San Francisco, Cal. Williams & Wilson, Montreal, P. Q. Chas. Churchill & Co., Ltd., London, E. C., England. Fenwick Freres & Co., Paris, France. Heinrich Dreyer, Berlin, Germany. Landre & Glinderman, Amsterdam, Holland.

The Flat Turret Lathe

Does Accurate Duplicate Work At A Rate That Makes All Other Methods Seem Extravagant. See Pages 12 And 13 For Further Particulars . . . . .

JONES & LAMSON MACHINE CO.

SPRINGFIELD, VT., U. S. A., AND 97 QUEEN VICTORIA ST., LONDON, E. C.

DIAMOND TOOLS

Special shaped carbon, black diamond, pointed tools for turning all materials of a tough, hard gritty nature on which a steel tool will not hold its edge. Hard rubber, fibre, phosphor bronze, etc. Hold their sharp cutting edges for months and can be sharpened, thus lasting for years.

THOMAS L. DICKINSON, M'f'r, 47 Vesey St., New York.

C. W. Burton, Griffiths & Co., London, Sole Agents for Great Britain.

KINKS

If you haven't bought at least one of the ten Hill **KINKS** Kink Books in the past six weeks, you are just six weeks behind the great number of active, progressive ambitious men who have siezed this opportunity. The best little helpers a man can have, only 50 cts. apiece (2/6)—beautiful books—and full of meat. Don't delay. Send for Circulars now.

HILL PUBLISHING CO., 505 Pearl St., New York.

Black Diamond Files and Rasps

PERFECT ALWAYS

Twelve Medals Awarded at International Expositions

For Sale Everywhere

Copy of Catalog will be sent free to any interested file user on application

G. & H. BARNETT CO., Phila., Pa.

A Standard Grinder On Column

One of six sizes

Bath and Boxes

The very best low priced Grinders

Diamond Machine Co.,
Providence, R. I.

Machine Work on Steel-mill Machinery

Time Consumed in Roll Turning, Use of Milling Cutters for Machining Bearings, Results Obtained by Moving the Drill Press to the Work

EDITORIAL CORRESPONDENCE

In the manufacture of steel rolling-mill machinery, probably greater strides have been made in the improvement of the "hogging" machines than in any other class of work, as the larger part of this work is what is called rough machine work and the continual increase in the size of rolling mills of all kinds has been a great inducement to the men in the shop to continually increase the size of the cut in different machining operations as well as to increase the speed at which these cuts are taken.

The increase in the size of the castings means that a larger amount of metal must be left at the places to be machined with each increase in the size of the casting. This means that the tools must remove a larger amount of stock with each increase in size, if the said stock is to be removed in two cuts, that is, one roughing and one finishing, and to take more than two cuts would increase the cost of building these machines, while if the larger sized steel-making machines are to be made commercially successful the cost of machining must be reduced instead of increased.

Owing to the heavy strains put upon many parts of these machines, steel castings are being used where formerly iron was considered strong enough and this also means an increase in the time consumed in machining unless new methods, new tools or increased speeds are adopted to overcome it.

The Frank Kneeland Machine Company, one of the Pittsburg plants of the United Engineering Company, has utilized many new ideas in the methods of and tools used in doing the work, with the result that the cost of production is gradually being reduced.

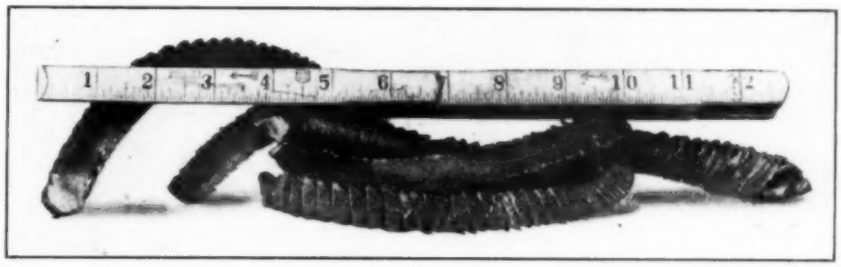


FIG. 2. SOME CHIPS FROM STEEL ROLLS

Roll Turning

One of their roll-turning lathes is shown in Fig. 1. This was originally bought from a dealer, but it is one of those tools which improves with age, like

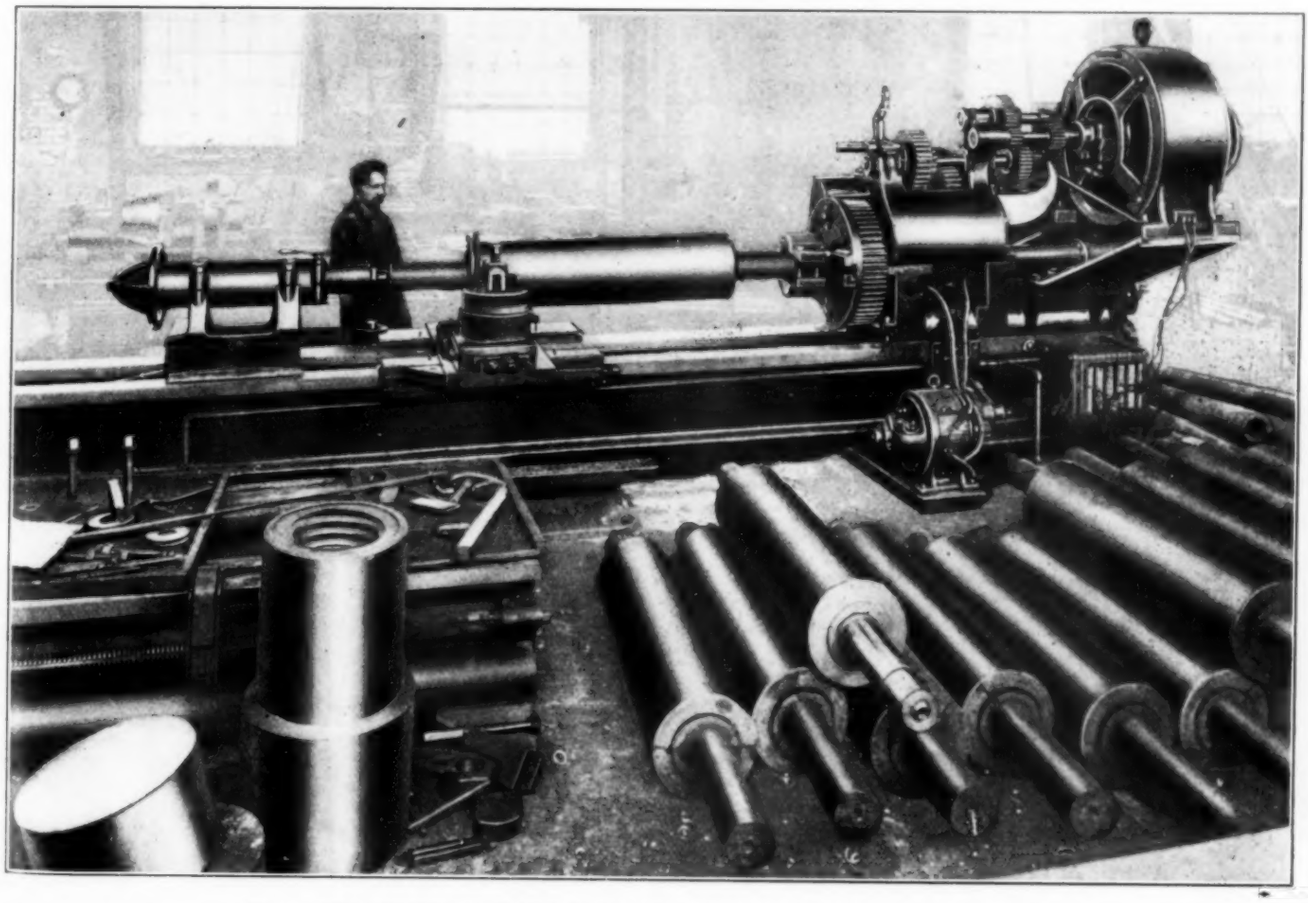


FIG. 1. ROLL TURNING AT FRANK KNEELAND MACHINE COMPANY, PITTSBURG, PENN.

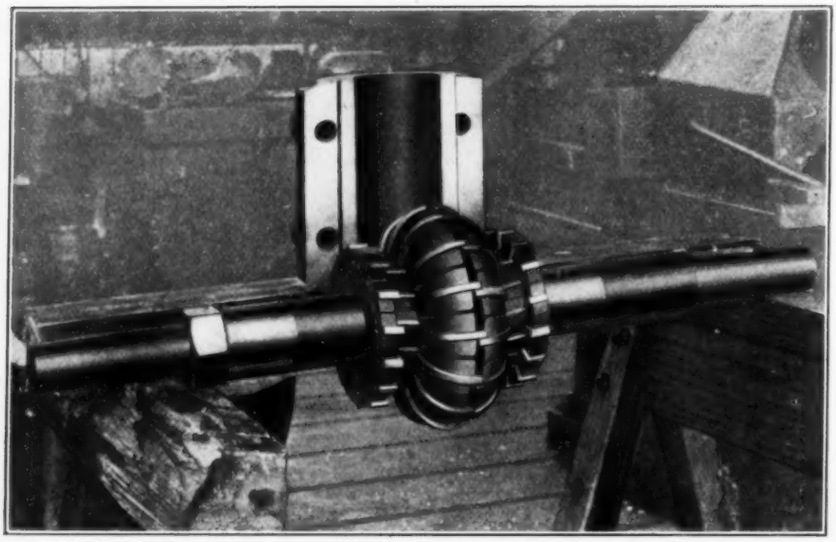


FIG. 3. ARBOR WITH CUTTERS FOR MILLING BEARING AND CAP

old wine, as it has been altered and added to until it can now be properly termed a Frank Kneeland lathe. For instance, the carriage became worn and broken and was replaced with a new and more modern one, the tailstock was replaced with a new one, the gears were changed and renewed and the feed and cutting speed increased, an electric motor was added to drive it and numerous smaller changes were made.

The rolls which are shown on the floor, one of which is in the lathe, are of steel and are 5 feet long on the roll part and 12 inches in diameter; 5/8 of an inch finish is allowed on these rolls in order to turn off all the loose-grained and porous metal and blow-holes.

This metal is turned off by two turning tools operating at the same time, one in the front and the other in the back of the carriage. The front tool takes off the roughing cut about ½ inch deep, while the back tool, which is inverted, removes the finishing cut of about ⅛ of an inch.

This size of steel roll is rough-turned and finished in 1 hour and 15 minutes, while cast-iron rolls of the same size are turned in about 50 minutes, high-speed steel being used for the turning tools.

Some of the roughing chips turned from the steel rolls are shown in Fig. 2 and their size can be judged by the rule photographed with them. They measured 7/8 of an inch on the cutting face of the chip, 1 inch on the back and ¾ of an inch on the side. These measurements, of course, varied with the trueness with which the rolls were centered. With some of the larger rolls, larger chips were obtained owing to the amount of stock being greater, which was left for finishing.

Milling Bearings

In handling ingots, slabs, bars, rails, etc., trains and carriers are required to bring the metal to and carry it away from the rolls. These require numerous rollers which have a bearing at each end to run in. This makes the machining of bearings and their caps a large item in

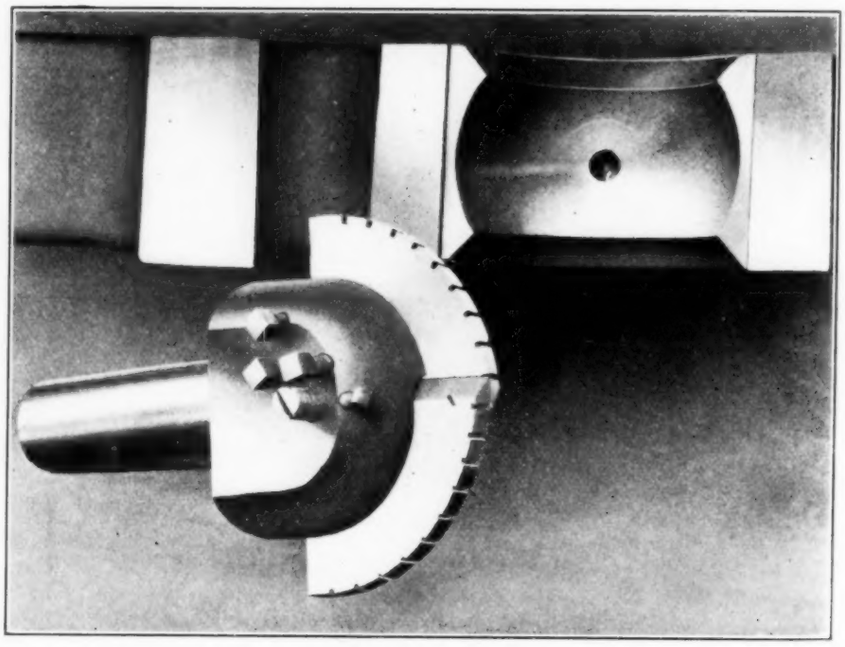


FIG. 5. CUTTER FOR MILLING BALL-SHAPED BEARING AND THE BEARING

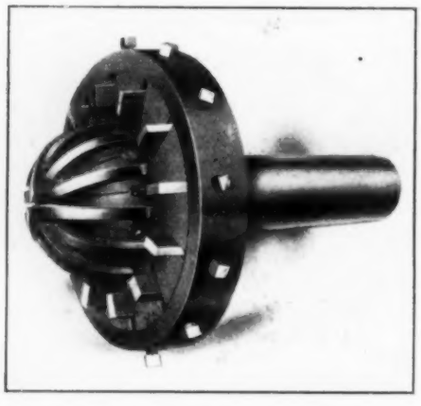


FIG. 4. ANOTHER STYLE CUTTER

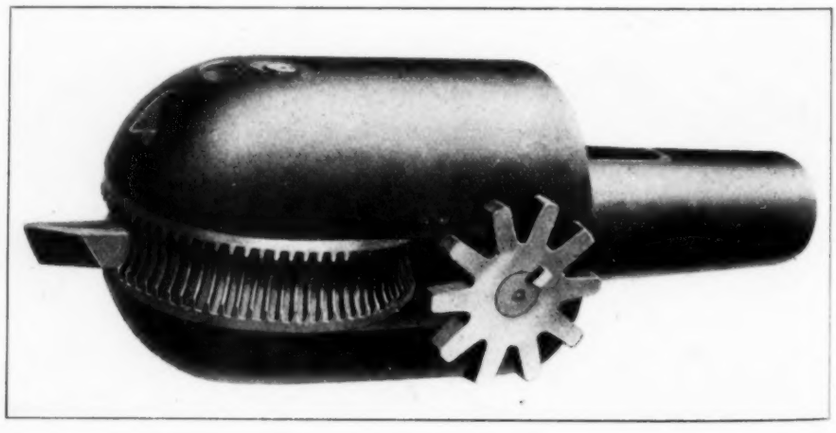


FIG. 6. ANOTHER STYLE CUTTER FOR BALL-SHAPED BEARING

the construction of steel-mill machinery.

The development of milling cutters in the past few years has led to the adoption of this style of machining in finishing caps and bearings by the Frank Kneeland Machine Company, and a reduction in the time and consequently the cost of machining has been effected. The cost of production is, of course, governed by the number of bearings and caps of a given size which are to be machined, as the milling cutters cost many times the amount that ordinary planer, shaper and boring tools do. But where the number of bearings and caps to be machined is large enough to warrant the making of milling cutters, the saving in time and power will soon pay for the making of the cutters.

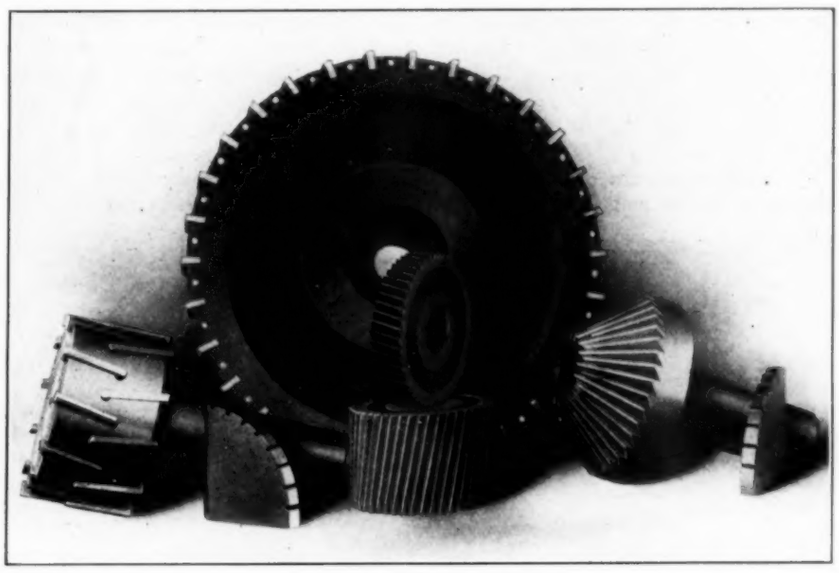


FIG. 7. A GROUP OF SPECIAL CUTTERS

In Fig. 3 will be seen six cutters assembled on an arbor ready to mill out the bearing cap shown in the background. These cutters are designed so that various sizes and combinations of sizes can be used on the same arbor to machine the different sizes of bearings and widths and shapes of flanges which are required.

Bearings of this style with the bore 6 inches in diameter by 15 inches long and the flanges 3 inches wide are machined in 40 minutes when they are made of steel and the caps to match are machined in 35 minutes. One-quarter of an inch of metal is left for finish and removed in this operation. The difference in time is due to the extra labor attached to moving the larger casting to which the bearing is attached. When these are of cast iron they are machined in 30 and 25 minutes respectively.

There is also another method employed in machining these bearings and that is to mill off both flanges of the bearing with the same operation, then mill the cap in the same manner, bolt the cap in place on the bearing and bore out the hole for the shaft with a boring bar.

Another Method of Milling Bearings

By Fig. 4 is shown another style of milling cutter for machining bearings similar to that shown in Fig. 3.

This style of cutter requires a complete tool for each size and shape of bearing to be machined and is therefore more expensive than the group system of cutters as shown on the arbor in Fig. 3. It, however, has the advantage of not having to be assembled and made to fit the job as it is always in the desired shape for use; the only labor attached to its use being to grind it when the cutters are dull and insert it in the machine. This gives it an advantage over the group style of cutter, but it has the disadvantage of having a dead center when cutting and the cutters on the round do much more work on the sides than they do at the extreme end, and therefore, require a great deal more grinding on the sides than at the center.

It is the cheapest style of cutter where a large number of bearings of the same size are to be machined, but when a few each of different sizes are to be machined the group style of cutter shown in Fig. 3 is the cheapest and most practical commercially. This last style has the advantage of giving the metal an even cut over its entire surface as it has no dead center to the cut.

The cutters, as will be seen in the halftones, are held in the holder by a taper headless screw which opens the slot cut for it and closes the slots in which the cutters are located.

Ball-shaped Bearings

The ball-shaped bearing shown in Fig. 5 and its cap are milled out with the cutter shown beneath it. The bevel on each side of it is finished with a cutter similar to that shown to the right of Fig. 7, and the bearing for the flange of the

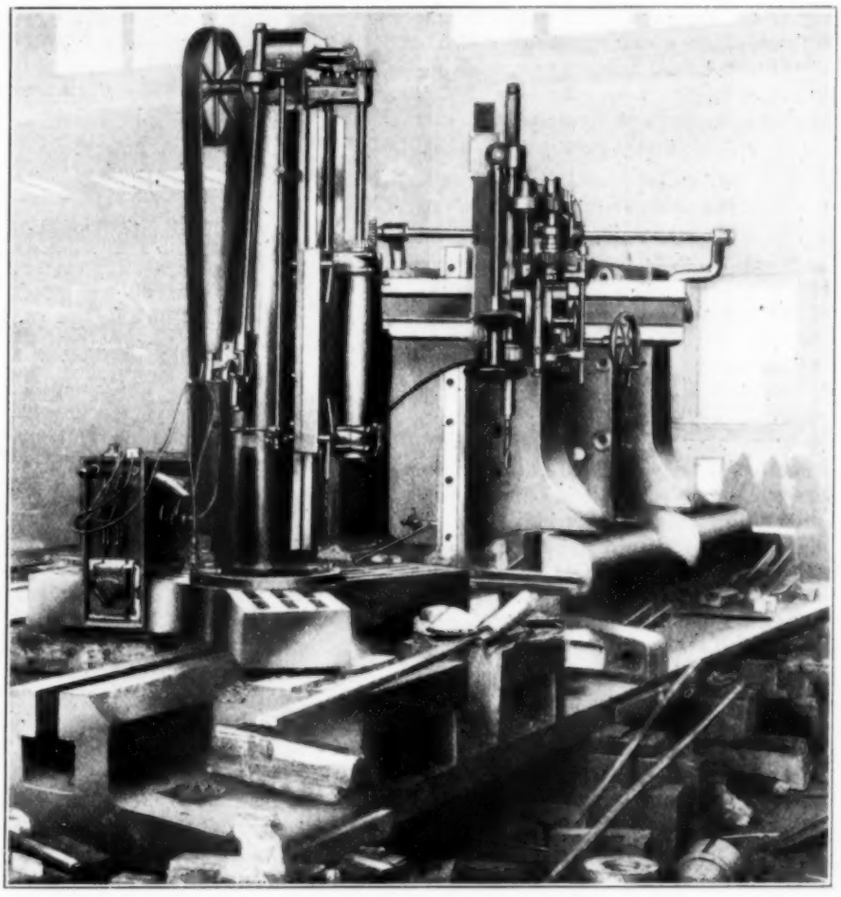


FIG. 8. MOVING THE DRILL PRESS TO THE WORK

cap to rest on is milled with cutters on an arbor similar to those shown in Fig. 3.

One-quarter of an inch of metal is removed from the ball-shaped bearing, in finishing it, when it is cast of steel. The one shown has a radius of 5½ inches and a width of 5 inches and it is machined in 45 minutes. When they are made of cast iron the time consumed in milling is only 30 minutes.

The tool shown in Fig. 6 is another method of machining the ball-shaped bearing. The cutter which is shown to the left of the tool is at its central point and is fastened in the gear wheel which is revolved on its axis by a worm to which the sprocket wheel shown is attached.

As the tool revolves in the machine the sprocket wheel comes in contact with a pin which turns it over, revolving the worm and gear wheel, and this moves the cutter away from the center. With the entire tool revolving and the sprocket and gears moving the tool at each revolution, the ball-shaped bearing shown in Fig. 5, can be turned.

This style of cutter has the advantage of being easily set for different sizes of bearings by merely shortening or lengthening the cutter, whereas the tool shown in Fig. 5 must have the cutters changed for each different size of bearing and these ground to a true radius.

One is the most economical where a large number of bearings of the same size are to be machined and the other where one or two are to be machined and the cutter changed to a different size.

In Fig. 7 is seen a group of special cutters used for this work. An idea of their size can be obtained from the fact that the large disk in the center is 16 inches in diameter.

Portable Drill Press

The beds, guides and ways for the roll housings, trains and carriages being usually large castings and consequently heavy, it is easier and a saving in time to move the machine to the work instead of moving the work to the machine.

In Fig. 8 is seen a portable drill press that is moved in this manner. The shop to handle this class of work economically must of necessity be fitted with traveling cranes, and therefore it is not a difficult proposition to move machines like the drill press shown from one job to another or from one position to another on the same job.

As will be seen in the half-tone the drill press has a long, swinging arm which gives it a wide range to operate in and it is driven by a motor which can be attached to the conductor wire in any part of the shop.

By moving the drill press to the top of the work as shown, holes can be reached to drill bore and counterbore that would require a much longer armed drill press if it was stationary and the arm had to reach over the work to get the proper location.

Some of the special tools shown can also be used in the drill press for machining operations on the bearings.

E. F. L.

A Compact Blueprint Room

By A. B. Howk

When our new drawing room was built, a room 7 feet 6 inches by 15 feet 6 inches was all that was alloted for the blueprint room. After a 54-inch Federal blueprint machine, taking up a floor space of 5x6 feet and a tank 30x64 inches for washing blueprints, was placed in this room, not much room was left to dry and mount blueprints. We were sorely puzzled at first as how to hang up the blueprints to dry. In our old building we had several lines up to hang the wet prints on, allowing the water to drip into a box of sawdust, but this arrangement was out of the question.

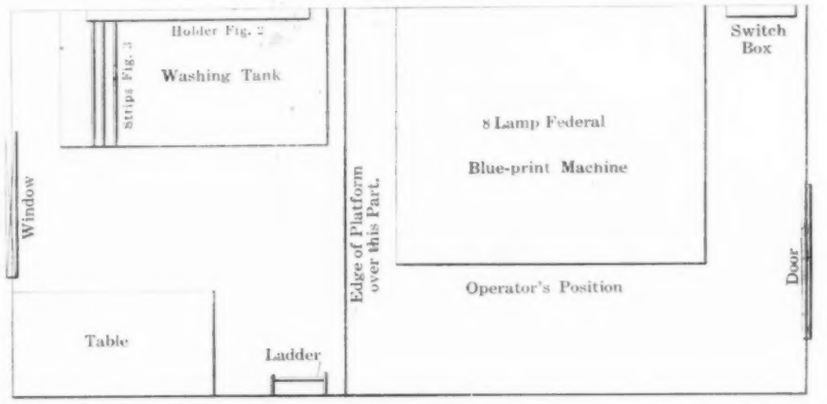


FIG. 1. PLAN OF BLUEPRINT ROOM

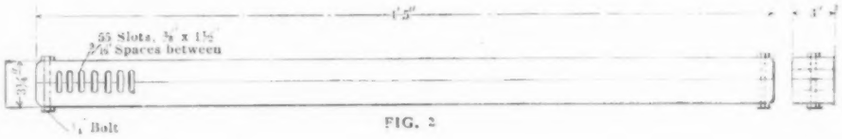


FIG. 2

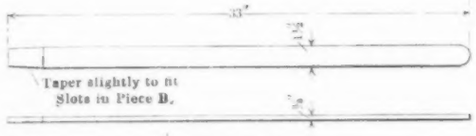


FIG. 3

DETAILS OF THE DRYING RACK

Most of the blueprints are 8x12 inches and mounted on press-board for the machine operators in the shop. After being mounted and dry they are given a coat of Marvelac which prevents the dirt and oil of the shop from injuring the print. Many days as high as 2500 blueprints have been made in eight hours. Now the question is, how do we dry so many?

Fig. 1 shows a plan of the blueprint room and location of machine, tank and platform, which will be spoken of later. The rack for drying prints is located 3 feet 6 inches above the washing sink and consists of a "holder" like Fig. 2, having spaces for 55 pieces like Fig. 3. A space of 9/16 inch separates each, leaving just space enough so the prints do not stick to one another. The strips, Fig. 3, fit into holder, Fig. 2, and are removable. A strip is removed, the wet blueprint placed on it and the strip is returned to the holder.

The rack is placed above the tank so that the water drips back into it. This prevents any water being on the floor, which is usually the case in drying prints. By overlapping the prints, as high as fifty can be placed on one strip. They do not dry as quickly as when not overlapped, but it is necessary many times. So our problem of drying blueprints is very simple and easily taken care of. Our largest prints, 4 feet wide by 6 feet long, are hung up by folding two or three times.

The table shown in Fig. 1 is for a card trimmer used to trim the small blueprints. A platform was put in after the building was completed, above the blueprint machine making an upper room, as shown in Fig. 1. On this platform is kept tracing cloth, drawing paper, blueprint paper, etc.; also a bench for mounting and preparing the 8x12-inch prints for the shop. This platform is reached by the ladder as noted.

Taking the blueprint department as a whole, considerable is placed in a small room, but still not crowded so it is inconvenient. Everything is arranged so it can be used to the best advantage.

A Worm Wheel Hobbing Machine

The Machine Used by the R. K. LeBlond Company for Hobbing Index Wheels and the Accurate Results Obtained by Their Method

BY W. F. GROENE*

This machine has been designed and built primarily for producing accurate worm wheels for our universal and plain dividing heads. As we have been making milling machines for the last eight years with very few complaints, they must have met all requirements of commercial accuracy. Nevertheless, we have given this problem careful investigation in the belief that by hobbing the wheel under ideal conditions in a head expressly built for this purpose, we would be able to produce a wheel that would meet the most exacting requirements.

*Chief draftsman, R. K. LeBlond Machine Tool Company.

The results obtained have justified our efforts in this direction, as shown by tests made on quite a number of wheels, and the appended list gives the maximum error found in each case in a series of 25 wheels, as shown with the test indicator. The three principal requirements covering ideal conditions for an accurate wheel were:

First, an accurately cut master wheel.

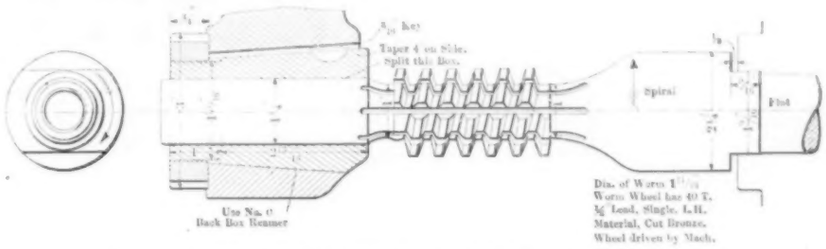


FIG. 2. THE HOB AND THE WAY IT IS SUPPORTED

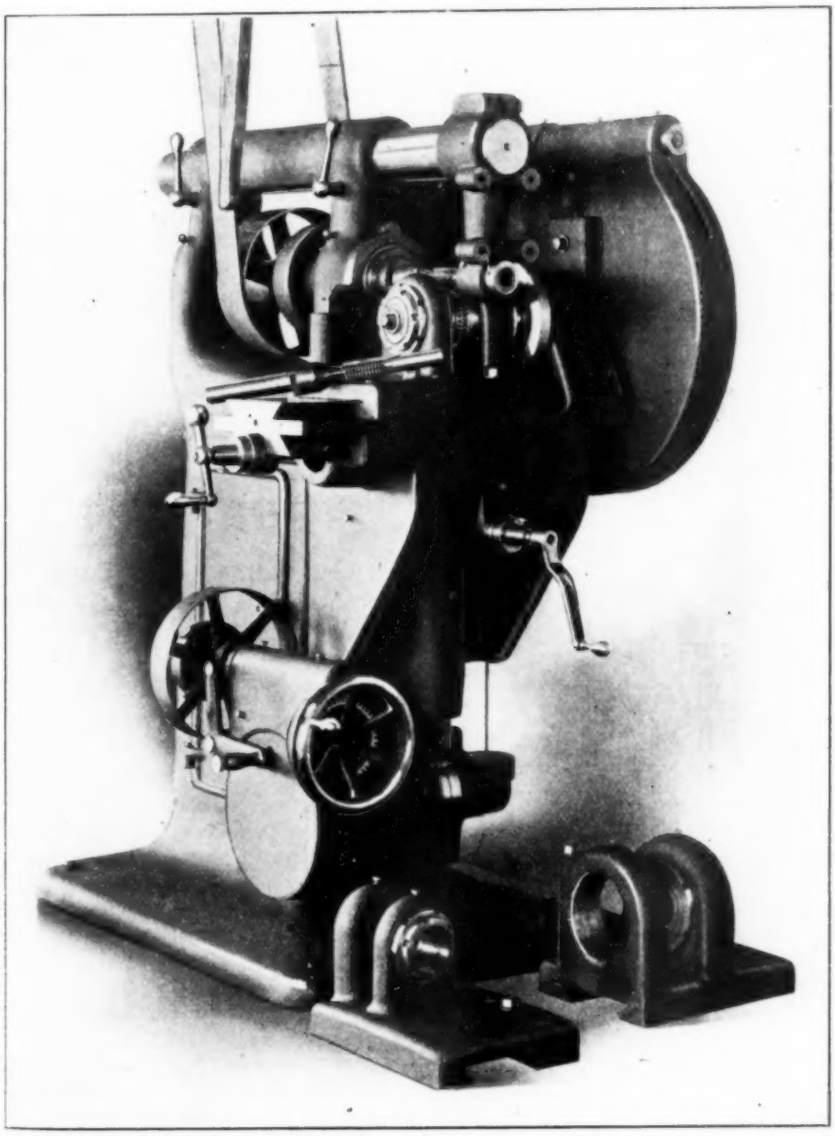


FIG. 1. A WORM-GEAR HOBBING MACHINE

The wheel in this machine has 120 teeth, ½-inch circular pitch, and is 25 inches diameter, or about four and a half times the size of the wheel to be hobbed. This wheel was made by the Gleason works under a guaranteed accuracy. This wheel is shown made in one piece, but the wheel as received from Gleason is made in two sections and bolted together. The wheel was tested upon its receipt with a 36-inch bar, by the same method as will be described later in testing our dividing-head wheels, and the maximum error was found to be 0.0025 inch on this diameter.

Second, hobbing the wheel under the exact conditions which it is to run in the head. To this end the worm wheel is pressed and keyed on the spindle and hobbed in a special fixture, the spindle running on its own journal exactly as when in position on the dividing head.

Third, rigid and substantial construction of the machine, to absorb vibration and insure accuracy. To this end we have selected for the body of the machine one of our No. 3 milling-machine columns. The spindle is tapering and has means of taking up both lateral and vertical motion and is substantially the same as used on our standard milling machines and is driven directly from the countershaft with belt. The hob is made in one piece with taper shank, as shown in Fig. 2. It is driven by clutch and held in the spindle with a bolt. The outer end is supported from the over-arm of the machine and runs in bronze bush. The master wheel and its spindle are driven from the spindle through gears mounted on a double-swinging quadrant. Adjustment between the worm and master wheel is obtained by moving the entire casing carrying the worm up or down, with a set-screw clearly shown in Fig. 1.

The dividing-head spindle with the

worm wheel to be cut is held in a special rest or fixture. The spindle is carefully adjusted to take up end play on the rear bearing with the small nut shown. A large nut is used for adjusting the bush (in which the rear spindle bearing revolves) laterally, to bring the front taper bearing of the spindle to its seat in the fixture. This fixture is mounted on the extended slide cast integral with the master-wheel spindle bearing. This slide also has a dovetail on its lower side, which fits the knee. End adjustment is by the screw and ball crank, seen at the end, for bringing the work central with the hob.

Connection between the two spindles is made with flanged nut screwed on the nose of the dividing-head spindle and clamped in position against the shoulder by a long cap-bolt. The flange on this nut is about 1/16 inch thick and is bolted to the master-wheel spindle by two cap-screws, near the outside diameter. This gives an absolutely positive connection between the heads, and at the same time the large diameter and the thinness of the flange gives a flexible joint to compensate for any slight inaccuracy of the alinement of the two spindles.

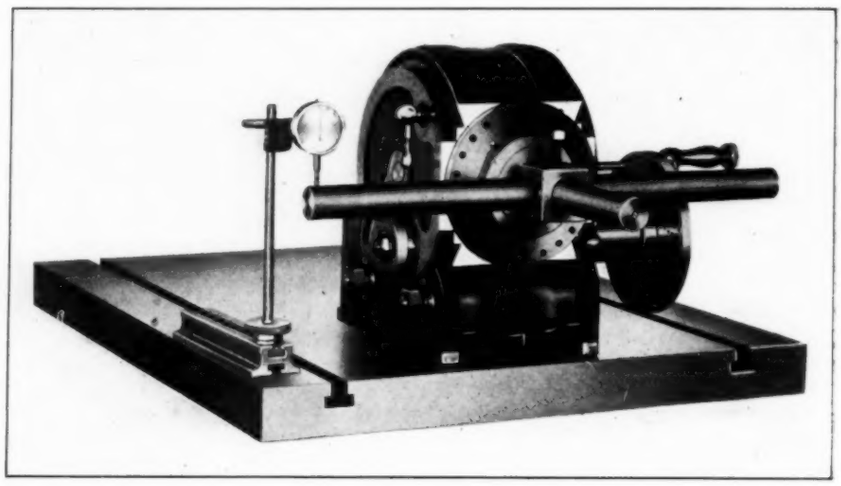


FIG. 4. TESTING THE ACCURACY OF THE WORM-WHEEL

The Feed

The work is fed vertically to the hob by the cam below the knee which is driven from the countershaft through the worm and worm-wheel. Means are provided, with a clutch on the pulley and the bell-crank lever for knocking off the feed when the cam has fed the work to the hob and returned it to position, this bell-crank lever being actuated by a stud in the worm-wheel. The depth of the cut is obtained by regulating the stud which bears on the cam. This stud is tapped out to receive the feed-screw, which in turn is actuated by the crank on the knee and the pair of bevel gears, shown in Fig. 3.

In practice the cam is set to its highest point and the knee elevated until the hob touches the work. This cam is then turned to its lowest point and the additional amount required for the depth of the cut is added.

The cam is laid out to give a very fine feed and when the proper depth is obtained, to give the work a dwell, allowing the spindle to run several revolutions and then gives a quick return.

Testing the Product

The method of testing the wheels for accuracy is illustrated in Fig. 4. We use a surface plate for this purpose. A plug is inserted in the spindle which is bored

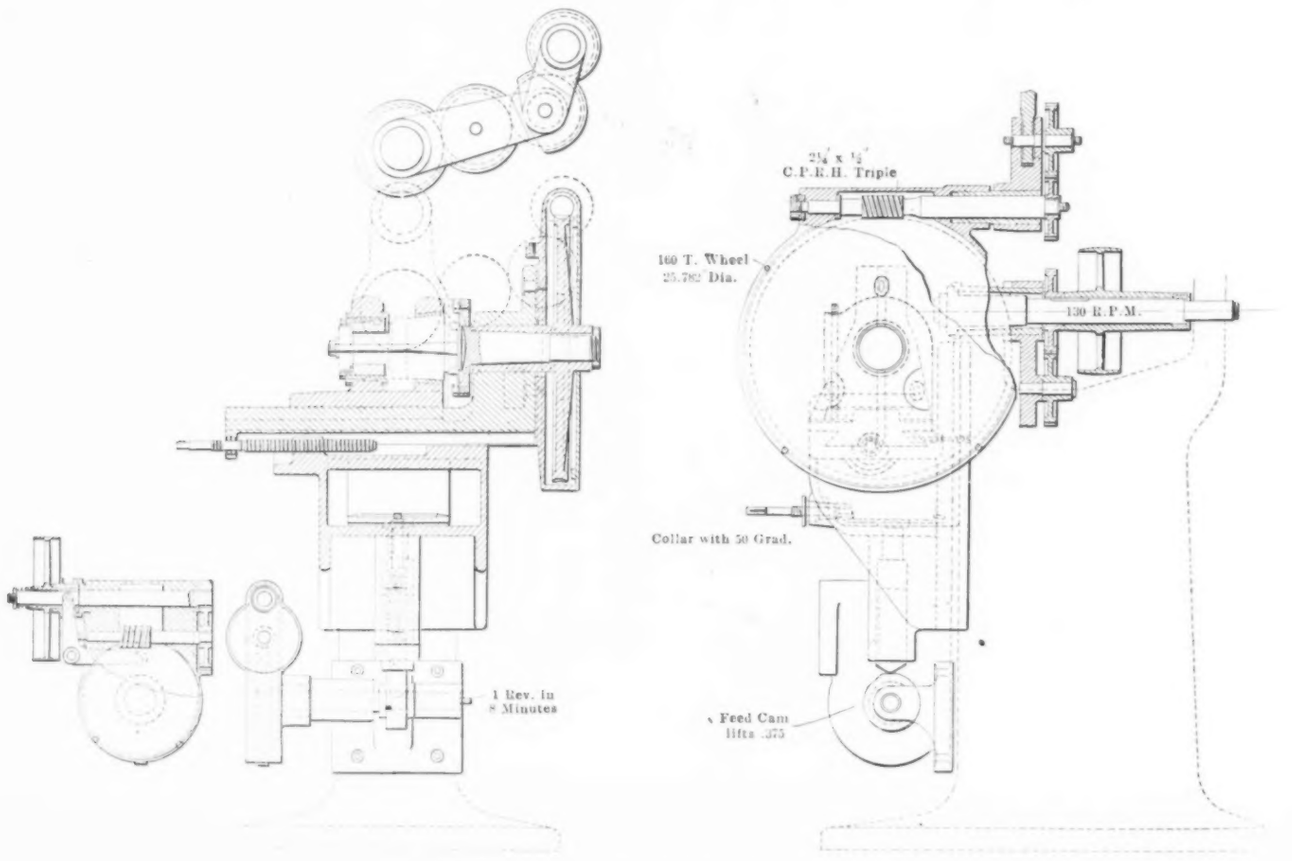


FIG. 3. SOME OF THE WORM HOBBER DETAILS

to receive the test bar. This test bar is made parallel by testing with the indicator, that is, by trying the bar alternately at the extreme ends with the indicator. The bar is then given a half revolution by making 20 turns with the index handle, and by again testing with the indicator as above the error is read. The error, of course, as shown by the bar, is twice the amount at which the wheel is actually out on this diameter.

We make this same test with the bar in four different positions and the maximum error, as we have found it, in a lot of 25 heads, as indicated on an 18-inch circle, is as tabulated below.

1... .001″	10... .0015″	19... .0025″
2... .001″	11... .0015″	20... .0015″
3... .0005″	12... .0005″	21... .0015″
4... .0015″	13... .002″	22... .0015″
5... .001″	14... .002″	23... .0015″
6... .0025″	15... .001″	24... .0015″
7... .0015″	16... .0015″	25... .0015″
8... .00025″	17... .00075″	
9... .00025″	18... .0015″	

TEST OF TWENTY-FIVE NO. 3 HEADS, FINISHED JANUARY 27, 1908, AS INDICATED ON AN 18-INCH CIRCLE.

Echoes from the Oil Country—The Evolution of a Boring Tool

By W. Osborne

I do not know anything about the original form of the first boring bar, but when the Boy first saw it the form had gotten to be somewhat like Fig. 1. The dimension varied according to the size of lathe, or more correctly, it varied according to the capacity of the tool post. In the early days some makers of lathes were careful to make a very modest sized hole in the tool post. It might have been a talking point, for a tool that is small does not require as much steel as a large one.

The dimension marked *A* varied between very wide limits, but was usually several inches. Occasionally, for large holes, the point would be put on the bar without its having been drawn out, but generally the other form was used and the Boy finally had gathered up a nice collection of them. It took constant vigilance to keep this collection intact, for most men in a jobbing shop have highly cultivated the art of taking advantage of another's absence to borrow anything which he may have in stock.

When a hole was to be bored the Boy would select the tool that was the proper length and size as near as he could. The dimension *A* had to be at least as long as the hole was deep, and often it would be several inches longer. After exercising all of his skill and patience, and a lot of the company's time, if he had good luck he got a reasonably straight hole if it was not a very long one, and he felt proud of it, that is, if he chanced to also get it of the desired size. To be able to hedge a little on this last point he early learned to make the hole before he made the piece which was to fit into it.

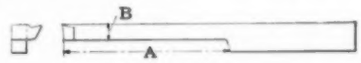


FIG. 1

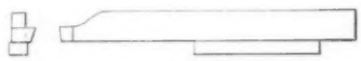


FIG. 2

FIG. 3

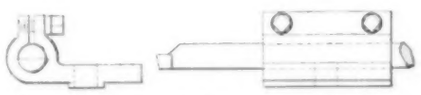


FIG. 4

THE EVOLUTION OF A BORING TOOL

In making these tools the dimension *B* was generally made about one-half the width of the bar. It finally filtered into the head of the Boy that if the nose of the tool was made, as shown in Fig. 2, the tool would go into as small a hole as one made from the same stock, but in the form of Fig. 1. It would also have the added advantage that one tool would do for long and short holes. By grinding away some of the front corners of the bar it would go into quite small holes.

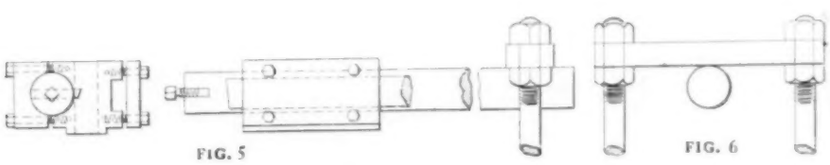


FIG. 5 FIG. 6

FINAL FORM OF THE BORING TOOL

In a short time the Boy had two of these tools made of different sized steel and he did not care who borrowed the other ones and forgot to return them. By having the tools made when a long hole was to be bored they were gotten of generous length. The blacksmith grinned at the monstrosities, but they saved him some work. It seemed to the Boy that a good bit of the boring came his way, and as it was so much easier to get a good hole than it had been with the old tools, he was glad of it.

One day, after he had ground away a lot of the front corners and some of the point of his tool to get it into a long small hole, he got to thinking that if the tool was round it would save some of that trouble, and the outcome of it was that he rigged up a tool like Fig. 3.

In using the other tool it had been necessary for him to make a new tool post with a longer slot in it, and to use a piece of steel under the tool to raise the point up to the center. He widened the slot all that it would stand and found that he could use a tool nearly the size of the hole it was to be used in, and then it had the advantage of a cutting edge that could be rolled either up or down.

Even with this tool it was not an easy matter to bore a straight hole a foot long, for the tool had the common failing of all boring tools of twisting around in the tool post in spite of wedges which usually fell out when they were needed the most.

To remedy this failing a casting was made and in time the tool, shown in Fig. 4, was in working order.

Now the Boy just ached for holes to bore. It was a delight to be able to get a foot into a hole 1¼ inches in diameter with a tool an inch in diameter and to be sure that it would not crowd around and spoil something. As time passed a larger outfit was made and then the Boy thought that if his head had been longer he would have made the big one first, and then by making a bushing for each other sized bar one holder would have been enough. This outfit would only fit one lathe. They did not have two of the same size and make in the shop. When one was needed for another lathe of larger size the Boy made it, as shown in Fig. 5.

By using a piece of shafting for the bar and putting in a piece of tool steel for the cutter, tool dressing was cut out, and as it was often necessary to face a piece as well as to bore it, the Boy added a seat for a tool on the front part of the block. With a tool here it was a short job to slip the bar back and the tool forward into position for facing, and the facing tool did not twist around under a heavy cut. In making this tool it took a few minutes longer to make it so that the tool-post wrench fitted the screws which held the cap for the bar and the clamp for the facing tool, and so that the tail-stock wrench fitted the bolt which held it to the tool-post carriage, but as the Boy expected to have to use it quite a lot he did not begrudge the time.

So well pleased was the Boy with this rig that he thought it could not be improved on, and for quite a while he felt satisfied with it, but when holes about 30 inches long had to be bored, he did not like the way the tool post acted. If he took little nibbly cuts the time it took to do a hole disgusted him, and if he tried to take a decent sized cut he was afraid he would yank the tool-post carriage off

bodily. The way it acted when the tool went into and out of a sand hole made the chills run up and down his back; that was very disagreeable to him. He had never seen a tool-post carriage torn to pieces, and so had no precedent to guide him as to what kind of a story it would be best to tell the "old man" in case it happened with him.

By using a long bar for the long holes and fastening it down behind he transferred the strains from the tool-post carriage to the ends of the lathe carriage. As the bar did not extend much over the end of the carriage on the cutting end he reasoned that it would take quite a cut to tear the gibs loose and turn the carriage over. Fig. 6 shows the idea. With the bar stiffened in this way he found that he could take a much heavier cut than he had ever been able to before, but still he was not satisfied. A double-ended cutter was easily made. By shoving it over a finishing cut could be taken with the bar without changing tools. One end of the tool was used for roughing and the other end ground up in proper shape for a finishing cut.

The lathe that this rig is used on has a graduated cross-screw, and when the Boy gets ready to take his last roughing cut he runs it in about one-half inch and then runs back and pushes his tool over and gets the size of his finishing cut with the tool on the back side. It is the work of a few seconds to set the micrometer dial to zero, and then he proceeds with his last roughing cut. When that is through he sets over to his zero for the finishing cut and takes it as the bar is feeding out.

While roughing he also makes use of the micrometer graduation on his cross-feed. It is so much easier to grind the tool so that it will cut on both sides and cut both going and coming than it is to do all the feeding one way. By watching the graduations there is no danger of setting the cut too deep.

When the Boy had a support below the bar as well as the one above it, and had the bolts pulling the bottom one down on two pieces of pipe cut just right for length, and had the two pieces separated by pieces of pipe just a feel shorter than the diameter of the bar he found he had a very fine contrivance. Even a sand hole did not make the bar jump.

Trying to save time he tried some double-ended cutters which were nearly to size. These would "hog" the stock out very rapidly, but if the core happened to be a good bit out there was danger of not having enough stock for finishing so that this method had to be used with care.

Just where the ideas came from that drifted into the Boy's head I do not know. He does not lay claim to any great originality, yet this evolution was not in any sense a copying of anything that he had ever seen. It was rather the result of having ideas in the head and a willingness to have them work in conjunction with the needs at hand on the outside. He is not the only Boy who has ideas and keeps them working, and so he is not attracting any special attention, but he has had quite a lot of fun making the machinery do his work in an easier and more satisfactory manner, and I think that such things have helped his wages. At least he is getting more than some of the other boys.

Sizes of Shafts without Mathematics

Either the Diameter, Stress or Moment Can Be Found for Shafts Subjected to Twisting, Bending or Combined Twisting and Bending

BY JOHN H. BARR*

The accompanying chart affords means for rapidly solving problems involved in designing or checking shafts having a solid, circular cross-section. It is used without any numerical computations whatever, and is applicable when the straining action is either a simple twisting or bending moment or a combined twisting and bending moment.

This chart can be employed under any of the above named straining actions for determining:

1. The diameter of a shaft for known moments and given intensity of stress.
2. The intensity of the stress in a given shaft under known moments.
3. The moment in a given shaft corresponding to any intensity of stress.

The chart as drawn covers all possible moments and shaft diameters and all intensities of stress up to and including 15,000 pounds per square inch; it is possible that more convenient scales might be chosen to cover a certain restricted range.

The construction of the chart is based upon the familiar formula

$$T = \frac{\pi}{16} d^3 f, \qquad (1)$$

in which T = the twisting moment in inch-pounds; f = the intensity of stress in the outer fibers in pounds per square inch; and d = the diameter of the shaft in inches.

From equation (1) we derive

$$T = (0.196\, d^3)\, f \qquad (2)$$

from which it appears that *for a given diameter of shaft* T is directly proportional to f. When d is a constant it is apparent that equation (2) is the equation of a straight line.

Construction of the Chart

Let the vertical scale of the diagram (*Scale A*) represent moments in 10,000-inch-pounds; for example, the ordinate corresponding to 0—9 of the scale is taken to represent a moment of 90,000 inch pounds. The upper horizontal scale (*Scale B*) represents intensities of stress in 1000 pounds per square inch.

If a shaft four inches in diameter is subjected to a stress of 10,000 inch pounds under the action of a twisting moment, it is found by equation (2) that this moment is $T = 125{,}500$ inch-pounds. The point marked a is located so that its ordinates are 125,500 (corresponding to T) and 10,000 (corresponding to f); therefore, from equation (2), a straight line drawn through this point a and the origin 0 gives all relations between T and f for a 4-inch shaft for moments not exceeding 130,000 inch-pounds. In a similar way other such diagonal lines can be drawn for shafts of other diameters by locating a single point for each; the chart as shown was so constructed.

It will be noted that the diagonal through the point a bears the three numbers, 0.862, 1.86, 4.0; likewise, each of the other diagonals bears three numbers. The purpose of these is to enhance the accuracy of the diagram for a given size of sheet and to extend its range.

With a twisting moment of 12,550 inch-pounds and a stress of 10,000 pounds per square inch the diameter of the shaft is 1.86 inches.

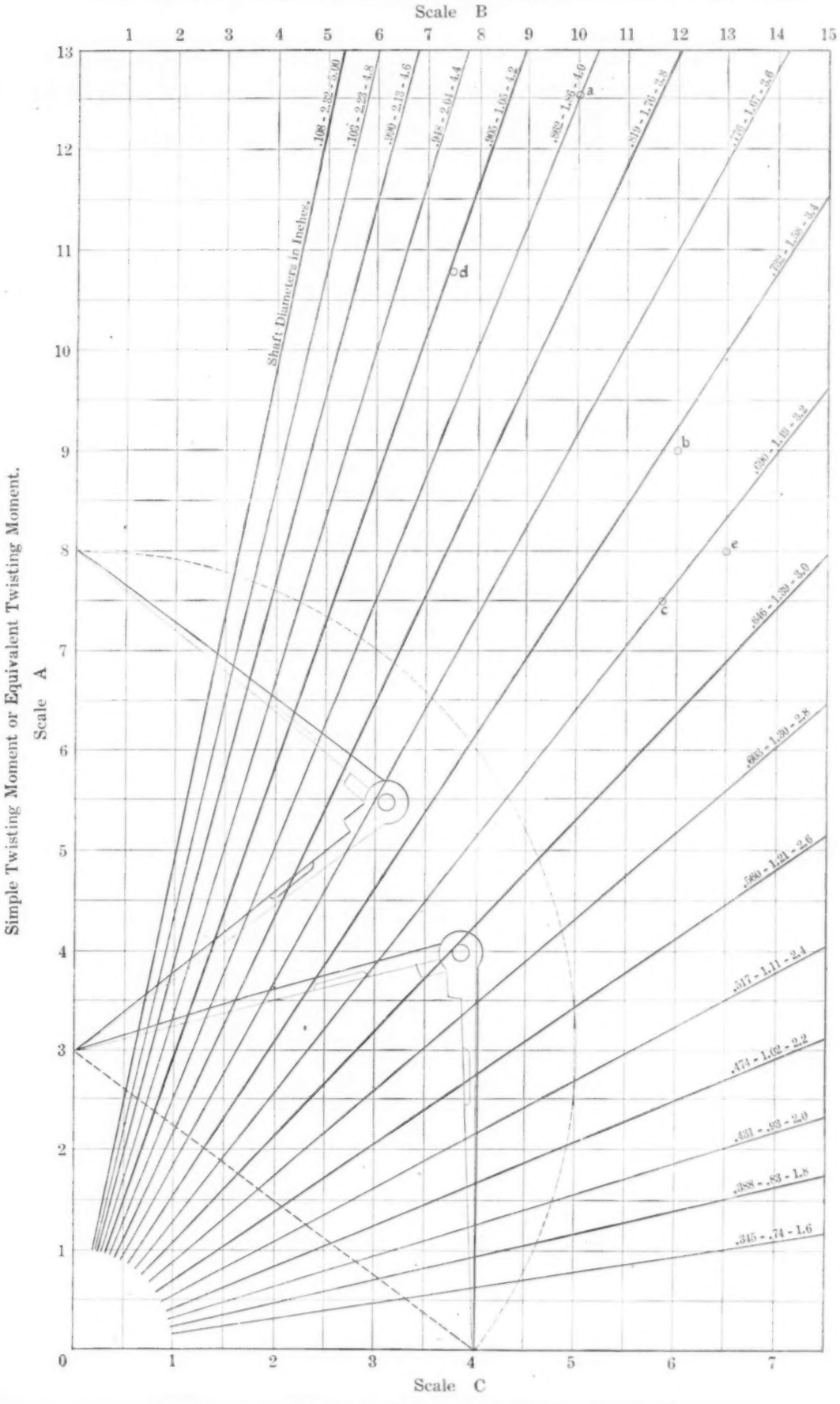
The second number on the diagonal through a is 1.86 which is the diameter of shaft corresponding to that diagonal when *Scale A* is taken in moments of 1000 inch-pounds, or 1/10 those used in illustrating the construction of the diagram.

With a twisting moment of 1255 inch-pounds and a stress of 10,000 pounds per square inch the diameter of the shaft is 0.862 inch.

The third number on the diagonal through a is, therefore, the diameter of shaft corresponding to that diagonal when

*Factory manager, the Smith Premier Typewriter Company. Formerly professor of machine design, Cornell University.

Intensity of Fibre Stress. Each Numbered Division equals 1000 Pounds per Square Inch.



Simple Twisting Moment used only to find Equivalent Twisting Moment.

RELATIONS BETWEEN DIAMETERS, INTENSITIES OF STRESS AND MOMENTS FOR SOLID, CYLINDRICAL SHAFTS

For explanation of the use of the chart see reverse of this sheet.

Relations between Diameters, Intensities of Stress and Moments for Solid Cylindrical Shafts

This chart is applicable to the solution of problems in connection with solid cylindrical shafts, subjected to twisting, bending, or combined twisting and bending moments. It can be used without any numerical computations whatever for determining the following factors: (1) The diameter of a shaft for given moments and intensity of fiber stress. (2) The intensity of the stress in a given shaft under known moments. (3) The moment in a given shaft corresponding to any intensity of stress.

As plotted it covers all possible moments and shaft diameters, and all intensities of stress up to and including 15,000 pounds per square inch.

a. To find the required diameter of a shaft for a given twisting moment and a given intensity of stress. Scale *A* represents the twisting moment in inch-pounds. Each numbered division may represent 100, 1000 or 10,000 inch-pounds, as the nature of the problem demands. Scale *B* represents the intensity of the fiber stress and each numbered division represents 1000 pounds per square inch. Locate points on the scales *A* and *B* corresponding with the quantities given in the problem. From these points erect perpendiculars to the scales and find their point of intersection. If this point falls on one of the diagonals, the shaft diameter required will be the smallest quantity given on the diagonal if each numbered division on the *A*-scale has been taken as 100 inch-pounds of the twisting moment. If each division has been taken to represent 1000 inch-pounds of the moment, the shaft diameter will be the intermediate number on the diagonal. Similarly, if each division has been taken to represent 10,000 inch-pounds of the moment the shaft diameter will be the largest quantity given on the diagonal. If the point of intersection of the perpendiculars does not fall on a diagonal the values for a diagonal through that point can be obtained by interpolation.

b. To find the intensity of stress for a shaft of given diameter and acted upon by a given twisting moment: Find the diagonal corresponding to the shaft diameter or interpolate for its position. Determine the point on the *A*-scale representing the twisting moment, letting each numbered division represent 100 inch-pounds of moment if the smallest quantity on the diagonal represents the diameter given, or 1000 inch-pounds if the diameter is represented by the intermediate quantity on the diagonal, or 10,000 inch-pounds if the diameter is represented by the largest number on the diagonal. Trace a horizontal from this point on the *A*-scale until it intersects the diagonal representing the diameter. From this point of intersection trace a vertical until it intersects the *B*-scale. This last point of intersection will represent the intensity of stress required.

c. To find the twisting moment which will produce a given intensity of stress in a shaft of a given diameter: Locate on scale *B* the point representing the intensity of stress which is given and drop a perpendicular until it intersects the diagonal representing the diameter of the shaft. If necessary interpolate for the position of this diagonal. From this point of intersection trace a horizontal until it intersects the *A*-scale. The point thus found represents the twisting moment required. Each numbered division equals 100 inch-pounds if the smallest quantity on the diagonal represents the shaft diameter, or 1000 inch-pounds if the intermediate value on the diagonal represents the shaft diameter, or 10,000 inch-pounds if the largest value on the diagonal represents the shaft diameter.

d. To find the required diameter of a shaft for a given bending moment and a given intensity of fiber stress: Multiply the given bending moment by 2 and proceed as under *a*.

e. To find the intensity of stress in a shaft of given diameter acted upon by a given bending moment: Multiply the given bending moment by 2 and proceed as under *b*.

f. To find the bending moment in a shaft of given diameter and under a given intensity of stress: Solve as under *c* and divide the moment thus found by 2; the quotient will be the bending moment required.

g. To find the diameter of a shaft required for a given combined twisting and bending moment and with a given intensity of fiber stress: Lay out the value of the bending moment on scale *A* as outlined for the twisting moment under *a*. Similarly, lay out the twisting moment on scale *C*, using the same value for each scale division as was used for each division of scale *A*. Set a pair of dividers as shown on the chart to the length between these two points. Add this length, to which the dividers have been set, to the length previously plotted on the *A*-scale. The point thus found will represent the value of the combined twisting and bending moment or the equivalent twisting moment. Use this point in the same way as the point representing the twisting moment was used under *a* and solve for the shaft diameter.

h. To find the intensity of stress for a shaft of given diameter, acted upon by given combined twisting and bending moments: Find the equivalent twisting moment as outlined under *g*; then solve for the intensity of stress as indicated under *b*.

i. To find the equivalent twisting moment for a shaft acted upon by a combined twisting and bending moment having given the diameter of the shaft and the intensity of the fiber stress: Use the method outlined under *c* for a simple twisting moment; the result will be the equivalent twisting moment. For a given equivalent twisting moment there will be an indefinite number of sets of values for the simple twisting and bending moments. If either *M* or *T* is known, the solution can be made directly. If the ratio of these moments is known, their values can be found by trial with the dividers by using the chart.

The range of the chart can be still further increased by giving larger values to each numbered scale division of scale *A*. If each scale division of scale *A* represents 100,000 inch-pounds of moment the corresponding shaft diameter is 10 times the smallest quantity on the corresponding diagonal. If each scale division of scale *A* represents 1,000,000 inch-pounds of moment the corresponding shaft diameter is 10 times the intermediate quantity on the corresponding diagonal, and so on.

Scale A is taken in moments of 100 inch-pounds.

Suppose the moment $T = 1{,}255{,}000$, or 1000×1255. It has been shown that with a moment of 1255 inch-pounds and a stress of 10,000 pounds per square inch $d = 0.862$; therefore, with this same stress and a moment of 1000×1255, or $(10)^3 \times 1255$, the diameter is equal to the cube root of 1000 times 0.862 or 8.62 inches. In a similar way, if the moment is 12,550,000 or $1000 \times 12{,}550$, the diameter is 10×18.6 inches, etc.

It thus appears that the range of the chart is unlimited as to moments applied to shafts; it can be used by observing the following rule as to *Scale A:* If the figures on *Scale A* are taken as representing twisting moments of 100 inch-pounds the smallest numbers on the various diagonals give corresponding diameters of shafts. If *Scale A* is taken as representing moments of 1000 inch-pounds use the intermediate numbers on the diagonals as representing shaft diameters. If *Scale A* is taken as moments of 10,000 inch pounds use the largest numbers on the diagonals. If *Scale A* is taken as moments of 100,000 inch-pounds use the smallest numbers on the diagonals with the decimal point moved one place to the right, and so on.

Use of the Chart for Simple Twisting Moments

1. Suppose it is required to determine the diameter of a shaft for a twisting moment of 90,000 inch-pounds with a fiber stress intensity of 12,000 pounds per square inch. *Scale A* is taken as representing moments of 10,000 inch-pounds. The point 9 on *Scale A* corresponds to $T = 90{,}000$ inch-pounds; the point 12 on *Scale B* corresponds to $f = 12{,}000$ pounds per square inch. The horizontal through 9 on *Scale A*, and the vertical through 12 on *Scale B* intersect at the point marked *b*, which lies somewhat below the diagonal bearing the number 3.4 at its outer end. This indicates that the required shaft is rather less than 3.4 inches in diameter; or that the shaft should be about 3⅜ inches in diameter.

If the moment had been 900,000 inch pounds (*Scale A* representing moments of 100,000 inch-pounds) the point *b* would correspond to a diameter of rather less than 10×0.732 or 7.32 inches, or by interpolation it would be found to be about 7.25 inches.

2. Suppose it is required to find the intensity of stress in a 1.5-inch shaft under the action of a twisting moment of 7500 inch-pounds. *Scale A* is now taken as representing moments of 1000 inch pounds. Passing horizontally from 7.5 on *Scale A* to the diagonal marked 1.49 (using the intermediate number on the diagonal) the point *c* is located. Passing upward to *Scale B* we get, by interpolation, a stress of about 11,700 pounds per square inch.

3. Suppose it is required to find the twisting moment which will produce an intensity of stress of 7500 pounds per square inch in a shaft 9 inches in diameter. Start at a point on *Scale B* half way between 7 and 8 and pass downward to point *d*, slightly below the diagonal marked 0.905 — 1.05 — 4.2; thence horizontally to *Scale A* where the reading is about 10.75. Since the given diameter is 9, or 10×0.9 the scale of moments is $\frac{1}{10^3} \times 100 = 100{,}000$ inch-pounds, and the required moment = 1,075,000 inch pounds.

Use of the Chart for Simple Bending Moments

The expression for a bending moment M is

$$M = \frac{\pi}{32} d^3 f, \qquad (3)$$

while the expression for a twisting moment is, as given above,

$$T = \frac{\pi}{16} d^3 f.$$

Therefore, for a given shaft diameter and *numerically* equal fiber stress, T is numerically equal to $2M$. To use the chart for known bending moments with solid circular sections, it is only necessary to multiply M by 2 to find the equivalent twisting moment T, or the twisting moment which will produce the same numerical stress as the given bending moment. If the diameter and stress are the known quantities, solve as for a shaft subject to twisting and divide the moment found by 2 to determine the bending moment which corresponds to the same numerical stress.

Use of the Chart for Combined Bending and Twisting Moments

When a shaft is subjected to combined bending and twisting moments, the equivalent twisting moment T_e, which will give a stress numerically equal to the resultant stress, is

$$T_e = M + \sqrt{M^2 + T^2}. \qquad (4)$$

This equivalent twisting moment is easily determined by the aid of *Scale C* at the bottom of the diagram (which is similar to *Scale A*) and a pair of dividers; if the simple bending moment M and the simple twisting moment T are known.

The use of the chart for this case is best explained by an example. If $M = 30{,}000$ inch-pounds, $T = 40{,}000$ inch-pounds and $f = 13{,}000$ pounds per square inch, find the shaft diameter. Scales *A* and *C* are taken to represent moments of 10,000 inch-pounds. Take M at 3 on *Scale A* with one point of the dividers and T at 4 on *Scale C* with the other point of the dividers; then the distance between the divider points, or the distance between 3 of *Scale A* and 4 of *Scale C*, represents

$$\sqrt{M^2 + T^2}.$$

Swing the dividers about point 3 on *Scale A* as a center until the other point rests on *Scale A* (at point 8); then $0 - - 8$ on *Scale A* $= (0 - - 3) + (3 - - 8) =$

$$M + \sqrt{M^2 + T^2} = T_e.$$

With the value of the equivalent twisting moment T_e, proceed as in the case of a simple twisting moment. The intersection of the horizontal through 8 of *Scale A* and the vertical through 13 of *Scale B* (corresponding to the stress of 13,000 pounds per square inch) is at the point *e*, and since the moments correspond to units of 10,000 inch-pounds on *Scale A*, the largest numbers on the adjacent diagonals are to be used. It is thus found that the required diameter is between 3 and 3.2 inches and by interpolation it will be found to be about 3.15 inches.

The same rule as given for simple twisting moments, in connection with the scale of moments, applies to the equivalent twisting moment and governs as to interpretation of the numbers on the various diagonals.

If the problem is to find the equivalent stress on a shaft of given diameter under the combined action of known bending and twisting moments, proceed as in the example just given to find the equivalent twisting moment; then solve as for a simple twisting moment.

If the intensity of stress and the shaft diameter are the known elements, the solution for the equivalent twisting moment is similar to that for the corresponding case of a simple twisting moment. The simple bending and twisting moments which correspond to this equivalent twisting moment are, in general, indeterminate; since there is an indefinite number of sets of values of M and T which will give the particular value of T_e when combined according to equation (4). The bending moment M equals ½ T_e when $T = O$, and M may have any value not exceeding ½ T_e. The twisting moment T equals T_e when $M = O$, and T may have any value not exceeding T_e.

If either M or T is known the solution is definite and can be made directly, and if the ratio between M and T is known the solution can be obtained by a few trials with the dividers, when T_e has been found.

Steel belting for the transmission of power is reported to have some advantages from tests made by a firm in Charlottenburg, Germany. It is claimed that in view of its solidity a narrower band can be used and as a result it can be very tightly adjusted. A unique contact is said to greatly reduce slipping, and it is further claimed that owing to its lightness the influence of centrifugal force is not so great and therefore permits increased velocity.

A Machine for Milling Screw-machine Cams

A Miller with Geared Mechanism and Positive Control for Producing Automatic Screw-machine Cams from a Correct Former

BY J. P. BROPHY*

In Fig. 1 is illustrated a front view of this machine, showing cams *A*, which are being milled, mounted on drum *B*. The shape of these cams is reproduced from the form *C*, which is bolted to the circular revolving table shown at the right-hand end of the machine. It can also be plainly seen at the left-hand side, and in the foreground, of Fig. 2. The guide roll *D*, which is mounted at one end of the table, is held against the form by 600-pound weights that hang from two cables, which may be seen at the left-hand side in Fig. 1. These weights are connected to the table by means of rack and pinions inside of the bed and can be disengaged from the table by moving a knob *E*, Fig. 1. When these weights are disengaged, the table can be moved by means of the pilot wheel at the center of the machine. This hand movement is for convenience in setting up the machine.

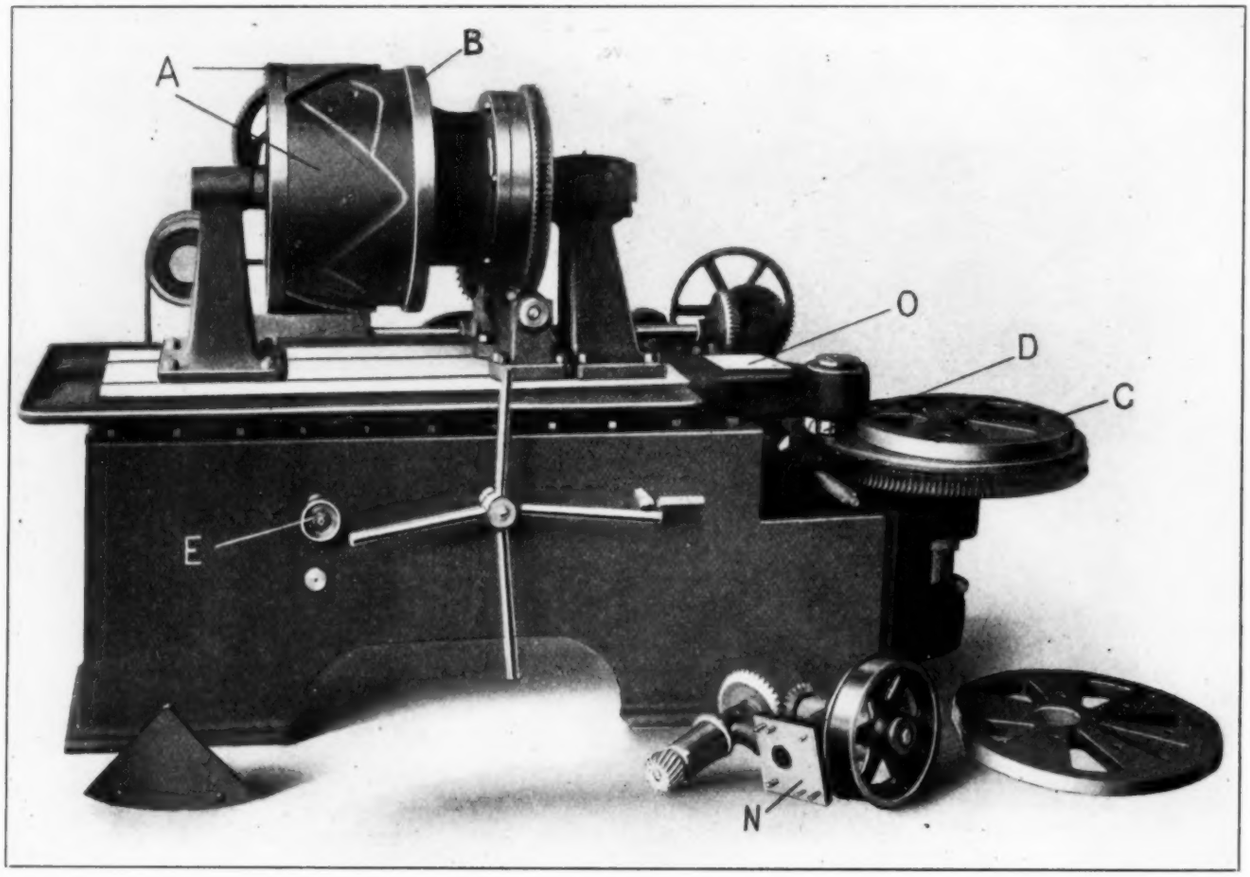


FIG. 1. FRONT VIEW OF CAM-MILLING MACHINE

The Driving Mechanism

Referring to Fig. 2, the drive for the entire machine, both of the cutter spindle and the feed mechanism, is by means of the large cone, shown at the right, which is driven by a 4-inch belt from the countershaft. The pulley is mounted directly on the cutter spindle, the cutter being at *F* at the extreme front end of the spindle. The cutter has an adjustment in and out to accommodate the different diameters of cam drums, the adjustment being obtained by means of rack and pinion, not shown. After the cutter is set to suit the diameter of a certain drum, the spindle is locked in position by clamping a large sleeve in which the spindle revolves. One of these clamps is shown just in front of the large step of the main cone pulley; the other cannot be seen in the half-tones, but is near the front end of the spindle. It will be seen that this makes a powerful drive for the milling cutter, it being operated directly by the 4-inch belt. The cutters used are of high-speed steel. A blast of air is kept blowing directly on the cutter to keep it cool and, also, there is an exhaust pipe which is placed directly over the cutter to carry away the fine dust which, otherwise, would settle over the entire machine. The feed mechanism takes its drive from the main cone pulley through the train of gears *I* and cone pulley *J*, the power being transmitted from this cone pulley to a cone below by means of the belt shown plainly in Fig. 2. The cone below drives directly the large friction disk *K*. Between disk *K* and the disk to the right of it is a friction roller, which is adjustable clear across the faces of the friction disks to vary the feed to suit different diameters of cams to be cut and, also, reversing the entire motion of the feed for a left-handed cam; this change being obtained by moving the friction roller to one side or the other of the center of the friction disks. The feed is transmitted through the worm, spur and spiral gearing shown, to the circular table carrying the form *C*

*Vice-president and general superintendent, the Cleveland Automatic Machine Company.

and the cam drum carrying cams A; all the parts in this mechanism moving in proper relation to one another.

Relation between Model and Work

As will be seen in Fig. 1, there are four cams A on the drum being milled, and the form C makes one complete revolution to each one of these four cams; that is, the entire outline of the form is used in making one of the cams shown, and as there are four cams on the drum at this time, the circular table carrying form C makes four revolutions to one of the cam drum. This rule holds good with any number of cams. The idea is that as many cams of a kind as can be placed around the periphery of the cam drum (one of which is shown lying on the floor at the right of Fig. 1) is as follows: The attachment N, shown on the floor in Fig. 1, is placed on the table of the machine at O. This attachment carries a milling cutter, and when the attachment is in place this same milling cutter takes the position of the guide roll D, which is shown in contact with the form C. This cutter is driven through the gears and the pulley by means of a belt from a small countershaft overhead.

Now, in laying out the shape of form C, an ordinary pencil is placed in position, instead of the milling cutter, at the bottom of the fixture N; a piece of wood ¾ inch thick is placed on top of the circular table and a piece of white paper is tern is planed on the bottom to insure a firm seat on the top of the circular table and is held to the table by means of fillister screws and large dowel pins; the milling cutter is then inserted in the attachment N, and the machine again started. In this way the milling cutter produces the exact finished form from the master cam on drum B. When the form is completed the attachment N is removed from the machine and the guide roll D put in place; then the cams which are to be milled are placed on cam drum B and the milling cutter F placed in the end of the cutter spindle; the weights are again engaged with the table and the machine is now ready to produce finished cams, which it does very rapidly. As an

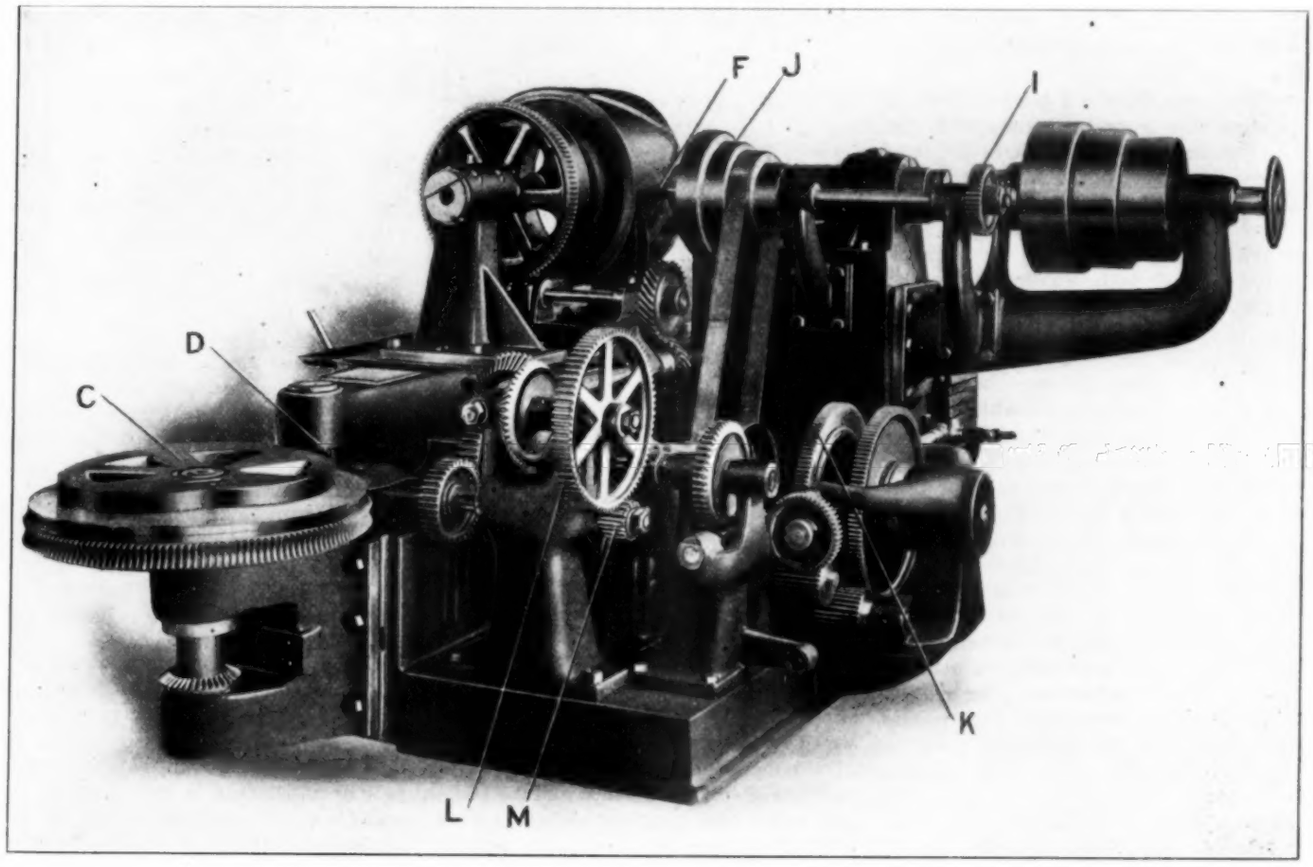


FIG. 2. SIDE VIEW OF CAM MILLING MACHINE

are put on at once and then the correct change gears put on to gear the form to suit the number of cams to be milled; that is, if two cams are all that can be placed on the cam drum, the table carrying the form revolves twice to one revolution of the cam drum and, if five cams are placed on the cam drum, the circular table makes five revolutions to one of the cam drum. This difference in rate of rotation between the circular table, carrying the form, and the cam drum, carrying the cams to be milled, is obtained by means of the change gears L and M, Fig. 2.

Making the Forms

The method of producing the forms fastened to this block of wood. A master cam, which has been previously made by hand, is then placed on cam drum B and a hardened-steel roller is substituted for cutter F, the weights are released by means of knob E, and the machine is then started up, the attendant meanwhile holding the master cam against the roll by pulling on the pilot wheel, shown in front of the machine, to keep a slight pressure upon the guide roll. The machine then generates an outline on the paper from the master cam on drum B. This paper is then removed and a pattern made to the shape, allowance being made for the diameter of the guide roll D, and finish being left around the periphery of the pattern. The casting made from this pat-

example, a set of three cams on a drum 8¾ inches diameter are finished in nine minutes; 4½ minutes being required for the roughing cut and 4½ minutes for finishing. As will be seen, it is necessary to make one form for each shape of cam desired, but the making of these forms is a very simple matter.

Weight and Capacity

The weight of the machine is 3¾ tons; it is 8 feet long by 7 feet 6 inches wide over all. The cams which are produced by this machine form an extremely fine job; this is on account of the weight and stability of the machine. The machine is capable of handling a cam drum, B, 30 inches in diameter. The worm which drives the

worm wheel of the circular table, upon which form *C* rests, is adjustable to take up any wear of the worm or wheel; the same is true of the worm underneath the worm wheel which drives the cam drum *B*.

This machine was designed and built by the Cleveland Automatic Machine Company for milling the cams used in connection with its automatic screw machines.

An Inspecting Indicator and a Milling Fixture

EDITORIAL CORRESPONDENCE

The making of calculating machines and typewriters necessitates extremely accurate work, and when you combine both of these machines in one as is the case in the Ellis adding-typewriter, there is even more extreme care in the making of every part, if possible.

The engraving shows an inspection gage or indicator for determining the accuracy of the piece *D* both with regard to the length *A* and the angle *B* which the left-hand end on the other arm makes with the rest of the piece.

As will be seen, there are two sets of multiplying levers, each of which multiplies 100 to 1, so that any variation is multiplied 100 times at the pointer above. The piece is simply slipped onto the center pin *C* and the right-hand end pushed up until it touches the stop *E*. If the distance *A* is correct the right-hand indicator will be at zero. At the same time the curved point of the left-hand indicator comes up against the underside or face of the left arm and indicates at once whether it is correct or not. The mark at each side of the zero line on both pointer plates indicates the maximum variation which is allowable, and it is the endeavor in this shop to keep all variations of this kind within one one-hundredth of a millimeter, or about four ten-thousandths of an inch.

The end view shows this indicator to have a cast-iron base that is raised from the bench both for convenience in operation and to allow springs *S S* or any other necessary mechanism to be easily arranged on the underside. The top is planed and ground and altogether it makes a very convenient and accurate indicator in addition to being very easy and quick to operate. It was originally intended to have a cam to force the arm *A* up against the stop, but it was found unnecessary, and its absence obviates the danger of forcing it so hard as to move the stop *E*, or distort the arm itself.

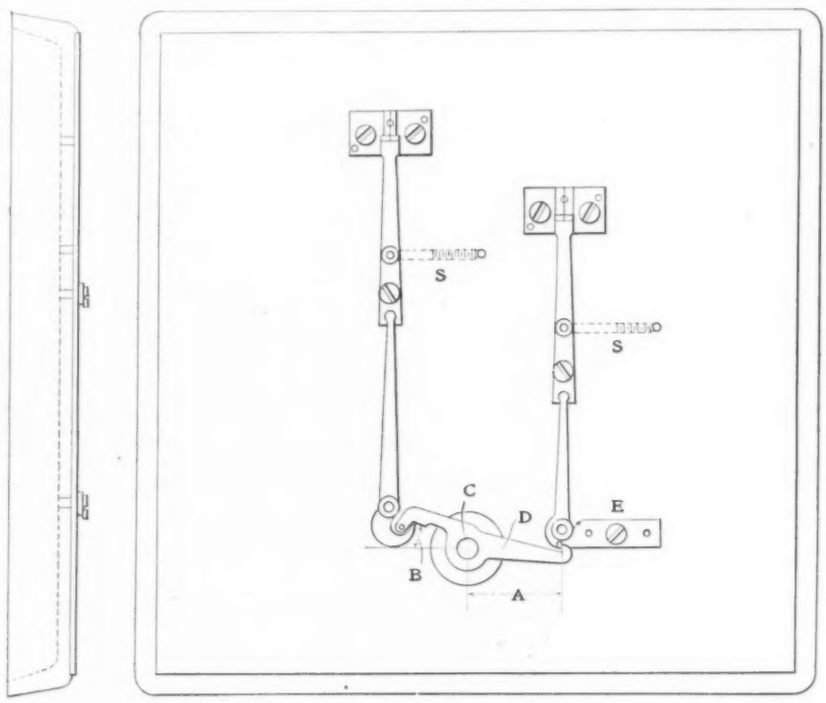


FIG. 1. INSPECTOR'S INDICATOR

THE MILLING FIXTURE

One of the pieces used in this machine is the U-shaped bar shown in Fig. 2, which is very light in section and is made of aluminum bronze. There are several surfaces of this to be milled and the problem was to hold it without springing. This was solved in a very interesting way by the milling fixture shown.

The four clamping devices, *A*, *B*, *C* and *D*, all consist of a pair of circular corrugated jaws mounted on a steel stem or rod, by which they are drawn together by the nurled nut on the end. These rods also serve as a support for the castings and locate its hight, as can be seen in Fig. 3, where the rods are marked *R*.

After loosening all the other jaws, the plunger *E* is drawn back and held out of contact by the thumb-screw *S* until all the other jaws have been tightened; then *S* is relieved and a light spring carries the plunger out against the piece after which *S* is again tightened, and in this way plunger *E* acts as a central stop which prevents side springing of the long part of the piece to be milled under the action of the milling cutters as shown in Fig. 3.

All of these jaws, with the exception of the pair at *A*, float in their bearings, as can be seen from the dotted lines; so that in placing a piece in this milling fixture all the jaws are open and the piece is first clamped at *A*, which is the stationary jaw; then clamps *B*, *C* and *D* are tightened, and as will be readily seen, they simply

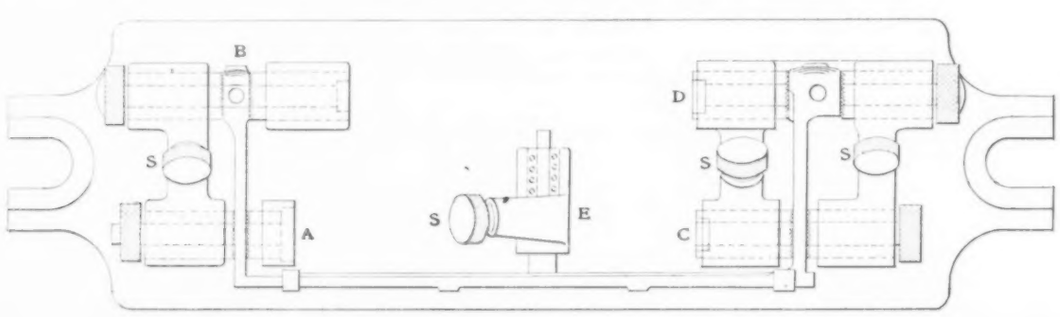


FIG. 2

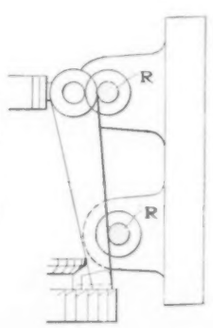


FIG. 3

A MILLING FIXTURE FOR HOLDING A LIGHT CASTING

draw together against the castings without any tendency to spring it in either direction, as both jaws float in the bearings on each side. After all these jaws are locked firmly on the piece to be milled, the thumb-screws *S S* are tightened to hold the jaws against further end movements.

This has proved highly successful, and the castings come out of the fixture without any spring whatever, and at the same time there has been no difficulty in locating each piece accurately or in holding it firmly during the entire milling operation.

Circular Beams

By Con Wise

A problem came up the other day to carry a trolley around a corner. It was a 4-inch bar of steel with a width of one inch. We were carrying it on hangers spaced six feet center to center in a straight line. The hangers were not stiff enough to consider the beam as simply supported at the ends. My mathematics and a hand book carried me far enough so that I found a safe load to be 2370 pounds for a fiber stress of 16,000 pounds per square inch. I did a little experimenting with rings of paper and card board, with the result that I found I did not know much about it and the additional discovery that there was a decided twisting stress on the beam which depended to some extent on the angle through which the beam turned between supports.

At this stage I called in the "Tech" fellow that has helped me out before and put the problem up to him. He kept putting off the solution till long after I had the trolley up and in use. Finally, after much tearing of hair and consulting of books and professors, he brought up the following: It looks sufficiently mathematical and mysterious so that I am going to offer it for approval, in the hopes that if it is all wrong it may at least bring out a correct solution. So far as I have been able to discover the text books are absolutely dumb on the matter.

First, let Fig. 1 represent a top view of the turn in the beam through an angle 2θ. While in the figure and in the actual problem this is taken as 90 degrees the solution should be applicable to a large range of angles. We assume that the ends of this section of beam are firmly fixed in position so that all distortion of the beam due to loading comes within the limits of the figure, otherwise the problem becomes so indeterminate that it would be hopeless.

These two assumptions are then made. First, this beam is the equivalent, so far as bending is concerned, of a beam of length $2a$ fixed at the ends and loaded in the middle. The bending moment at the support is $\frac{1}{8} P l$ where P is the load and l the length; in this case equal to $2a$, which reduces the moment to

$$\frac{P a}{4}.$$

Second, this beam is under a twisting moment at the ends of P, the load, times b. This twisting moment is equally divided between the two ends making the twisting moment equal to

$$\frac{P b}{2}.$$

Then from the usual formulas:

$$a = R \sin. \theta,$$
$$b = R (1 - \cos. \theta),$$

$$\frac{P R \sin. \theta}{4} = \frac{p I}{e}$$

and

$$\frac{P R (1 - \cos. \theta)}{2} = \frac{p_s I_p}{e},$$

where R is the radius of the center line of the beam, p the fiber stress in the top

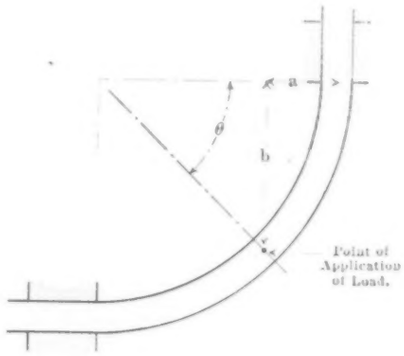


FIG. 1. DIAGRAM OF CIRCULAR BEAM

and bottom fibers due to bending alone, p_s the shearing stress in the top and bottom fibers due to twisting, I and I_p are respectively, the plane and polar moments of inertia of the cross section of the beam and e is the distance from the neutral axis of the top or bottom fiber.

Solving each of these equations for fiber stress we have

$$p = \frac{P R e \sin. \theta}{4 I}$$

$$p_s = \frac{P R e (1 - \cos. \theta)}{2 I_p}.$$

About all that my student friend could say for the reasons for his assumptions with regard to lengths a and b was that they seemed right to him and it made the relative values of the fiber stresses vary about as he thought they ought. That is, the nearer to a straight line the beam becomes the nearer the bending stress comes to that of a straight beam and the less the twisting effect becomes.

The formula for combining twisting and bending is

$$p_{\substack{max. \\ min.}} = \frac{p}{2} \pm \tfrac{1}{2} \sqrt{4 p_s^2 + p^2}.$$

Substituting the above values we have:

$$p_{\substack{max. \\ min.}} = P R e \left[\frac{\sin. \theta}{8 I} \pm \tfrac{1}{2} \sqrt{\frac{(1 - \cos. \theta)^2}{I_p^2} + \frac{\sin.^2 \theta}{16 I^2}} \right].$$

This gives us two values of the fiber stresses at any point, the greatest and the least, and they are at right angles to each other. If a body is acted on by two stresses at right angles the equivalent single stress which would produce the same effect is given by the formula:

$$p_e = p_{max.} - \frac{1}{m} p_{min.}$$

where m is Poisson's ratio of the sidewise deformation of a body under pressure to the lengthwise deformation.

Substituting the above values we get:

$$p_e = P R e \left[\frac{\sin. \theta}{8 I} \left(\frac{m - 1}{m} \right) + \tfrac{1}{2} \sqrt{\frac{(1 - \cos. \theta)^2}{I_p} + \frac{\sin.^2 \theta}{16 I^2} \left(\frac{m + 1}{m} \right)} \right].$$

If $\frac{1}{m} = \frac{1}{3}$, as in structural steel, then

$$p_e = P R e \left[\frac{\sin. \theta}{12} + \tfrac{2}{3} \sqrt{\frac{(1 - \cos. \theta)^2}{I_p^2} + \frac{\sin.^2 \theta}{16 I^2}} \right].$$

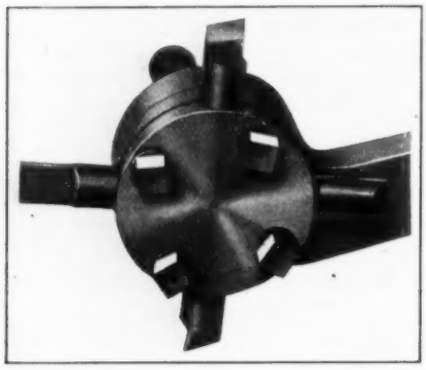
In the problem with which we started θ was 45 degrees and p_e was limited to 16,000 pounds; R the radius of the turn was to be found. I about a horizontal axis for the section $= 16/3$, I about a vertical axis for the section $= \frac{1}{3}$, I_p is their sum, or $17/3$, $e = 2$ inches and $P = 2370$ pounds, the same as the straight way part carried. Then $R = 31$ inches +. Will this solution pass muster?

It is proposed by the "United States Manufacturers and South American Trading Company," of No. 1 Madison avenue, New York, to establish a permanent sample exposition for American goods at Rio de Janeiro, Brazil. The exposition will be under the auspices of the Museu Commercial (Commercial Museum) of Rio de Janeiro, and the samples sent to it will enter the country free of charge. A charge will be made to exhibitors of approximately $4 per square foot per year.

Many tests have been carried on to ascertain percentage of swelling that takes place in cast iron and these tests have shown the possibility of producing a swelling of as much as 40 per cent. in the volume of cast iron, by heating and cooling. A bar measuring one inch square by 14.8 inches long was heated and cooled in a gas furnace 27 times, the high temperature being 1450 degrees Fahrenheit. Careful measurements then showed the bar to be 1⅛ inches square, and 16½ inches long. It is thought that this fact explains many of the difficulties experienced with cast-iron fittings for use with superheated steam where the same alternate heating and cooling take place.

Turret Tool Holder for the Lathe

There are many lathe jobs which require three or four different forms of cutting tools, and yet are not made in sufficient quantities to warrant removing the



TURRET TOOL HOLDER FOR LATHE

work from the lathe after each operation and doing all of the roughing, finishing, threading and cutting off at different settings.

To overcome this, and to avoid the time required for changing and setting different types of cutting tools, the turret tool holder shown herewith has been designed by Frank E. Bocorselski, superintendent of the Baush Machine Tool Company, Springfield, Mass. This consists of a vertical turret held on the end of a shank which fits the toolpost the same as the ordinary tool. The turret itself consists of a shank which fits in the holder and a large head for holding the tools. After the four holes are bored for these tools, a deep cut is taken around the turret through the center of these holes with a parting tool so as to allow the outer end to be clamped down on the tool by the clamping screws shown. This enables each tool to be held independently, and at the same time clamped firmly without having any loose pieces for this purpose, as this makes it much more convenient to remove or replace tools whenever necessary.

The turret carrying the tool points swings on its shaft and is indexed in the proper position by the spring pin shown at the back. After indexing it can be clamped solidly to the holder by the nut on the end of the turret shank, and in this way the tool becomes part of the shank itself, so far as rigidity is concerned.

This tool enables a piece of work to be finished completely if it can be done with the four tools that can be carried in the turret and there are many operations where such a tool should save a large amount of time, which is the great question in all machine work. Patent has been applied for.

It is well known that diamonds, though extremely hard, are also very brittle, and easily fractured by a sharp blow. It has been shown, however, that if a good diamond is placed between the jaws of a hydraulic press, and the pressure is applied without jerk, so as to avoid fracture due to brittleness, the jaws may be made to meet without the slightest injury to even the edges of the diamond, a perfect impression of which will be found in the hard steel jaws, which have closed around it and retained its image just like so much wax.

A Cam Cutter and a Planing Kink

At the shops of Manville Brothers, Waterbury, Conn., there is a very interesting machine for cutting such cams as

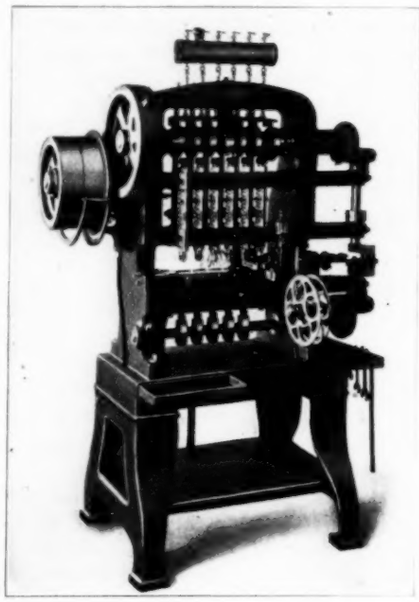


FIG. 3. THE GUIDES TO BE PLANED

are needed in their work of building wire-forming machinery. The machine is very simple in design, both the cam to be cut and the former being driven by the worm shaft shown in front in Fig. 1. The worm gear on the cam-cutting shaft is made to allow for slight

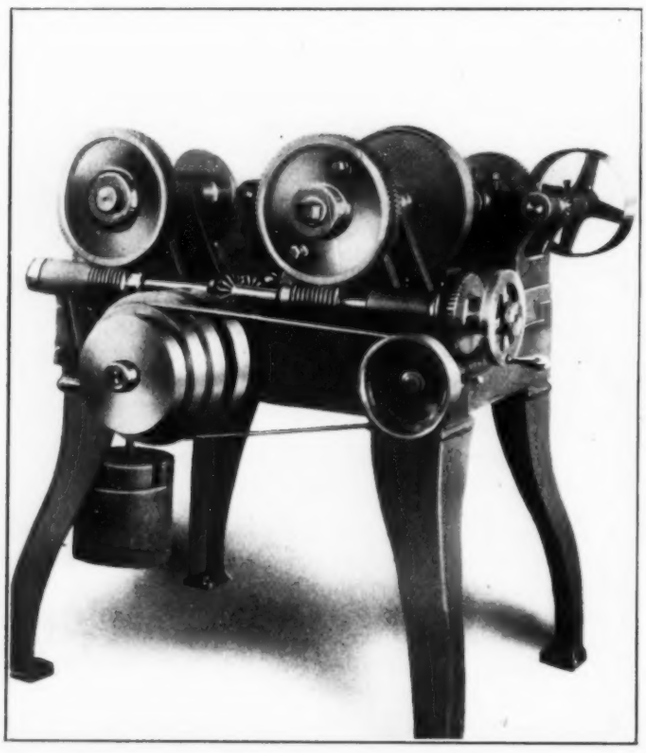


FIG. 1. A SIMPLE CAM CUTTER

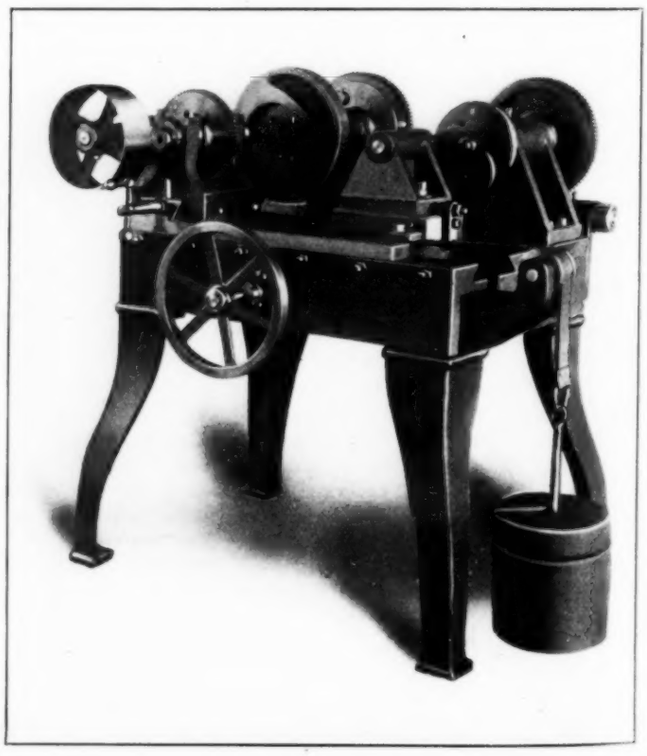


FIG. 2. THE OTHER SIDE

adjustment so that it is easy to set the work in the right position.

Fig. 2 shows the back view with the former roll kept against the former by the weight at the end, and as the milling cutter is on the same sliding head, both are moved by the same weight.

This was designed to cut face cams as shown in Fig. 2, but when it became necessary to cut barrel cams as well, they adopted the very ingenious expedient of putting on another worm at right angles to the worm shaft and driven from it by bevel gears. The same sized worm was used as before so that all that is necessary is to shift the head carrying the work from the position shown to one at right angles to it, which brings the periphery instead of the face of the cam, against the cutter, as in the normal position. It makes a very simple and effective way of shifting from one to the other and of adapting the machine for both purposes.

Planing Multiple Punch Guides

In planing the guides for the punches in Fig. 3, it is not an easy matter to get the guides the right distance apart unless you have a good system of measuring or locating them. This shop uses a method which is simple, but which gives very good results indeed.

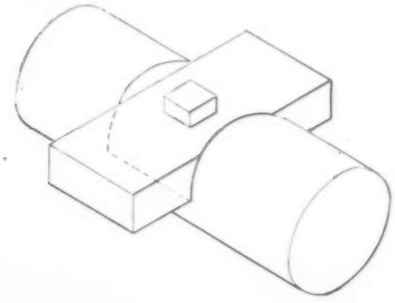


FIG. 4

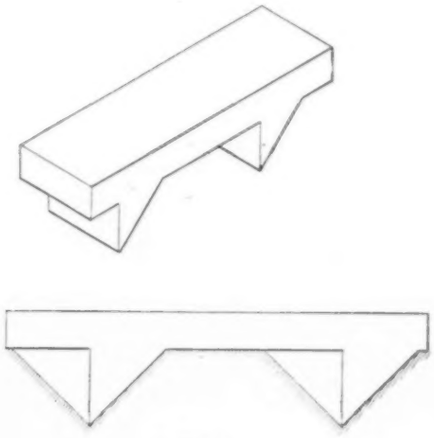


FIG. 5

GAGES FOR PLANING V'S IN MULTIPLE

First a planing guide is made as shown in Fig. 4, consisting of a piece of cold-rolled shafting planed down to the center in one spot for the cross or surface piece to be fastened on by the cap-screw shown. This is of such a size that when laid into a guide it will just touch the sides and the top as shown. This gives the correct size for the first and in fact all the guides.

Then the next guide is located by the gage in Fig. 5 which is the same plan as often used by lathe and planer makers in locating the V's with relation to each other. The second guide is planed so that the gage fits in the finished guide and against the first side of the second. When this is right, the other side is planed so that the first gage fits into it and then the next guide is laid out in the same way. Taken together they are very handy gages and can be used in a variety of work. F. H. C.

Ball Bearings for High Speeds

By J. Broadbent

During the exhibition held last year at the Olympia, as I was passing one of the machine-tool stands I was struck by the sound of an internal grinder which had just been brought into "cut" by one of the operators; it was the sound of a wheel kept rigidly to its work, a sound well recognized by a grinder, but too seldom heard. My attention was immediately arrested; I watched the machine at work for a time when I inquired as to the make-up of the spindle bearings. I was told they were a special ball-bearing type. I asked if they were experiencing any difficulty in keeping them free from play. The manager told me they could not detect any wear, and they had had them in use in their own works for some considerable time. His experience agrees with mine.

Some years back we had a number of holes 5/8 inch diameter to be ground accurately and parallel. We were then using an internal grinder of the regulation type which proved altogether too slow. We then made up one to run on balls. At first we had a little trouble with one end wearing loose, but we put in larger balls and the trouble ended and we had one of the most rigid internal grinders I had or have seen. We quite tripled our output. The wheels lasted longer, as they cut instead of rubbing.

One day I thought I should like to try the cast-off attachment at the same speed as we were running the ball-bearing one, 40,000 revolutions per minute. I had this belted up and told the operator to stand by the starting lever, we having first got as much oil into the spindle case as it would hold. In spite of this the spindle had not been running a minute when I saw the sleeve smoking; the heat had generated so quickly that before we could shut down, the outer end of the case was brown. That spindle we converted into a formed cutter grinder.

For some time I had to do with some light spindles running between 32,000 and 33,000 revolutions per minute. These were vertical, making lubrication far more difficult, and worse still, to the top end was connected an exhaust fan. The top bearing was limited as to size, so it was necessary to use small balls. At the bottom bearing it was possible to use larger balls. The first style of bearing tried was as Fig. 1. This gave a lot of trouble, and as it was expected that a great number would be wanted we had to look round for the cause of the trouble and a remedy. After going carefully into the matter I came to the conclusion that the centrifugal force of the balls was so great and the load so light that the balls instead of rotating as at *A*, Fig. 1, were compelled to rotate as at *B*, Fig. 1, thus setting up a grinding action on themselves and the races. I changed this style of bearing to the one in Fig. 2, making the parallel parts *A* and *B* free enough to be easily assembled. The radii *A*1 and *B*1 I made three-fourths the diameter of the balls to be used. The cups and cones were hardened and carefully ground and lapped. When these alterations had been made and the other details attended to I have not known these bearings to give any trouble except when they ran dry. Keeping them lubricated proved no easy matter, as we could not afford to have oil flying about as the finished work (cotton insulated-copper wire) was passing down through the center of the spindle.

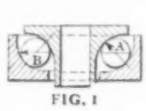


FIG. 1

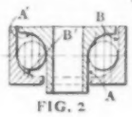


FIG. 2

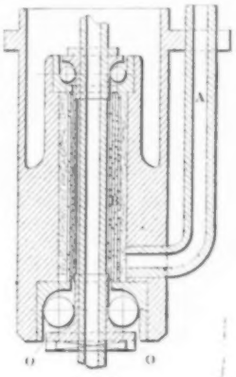


FIG. 3

BALL BEARINGS FOR HIGH SPEED

At Fig. 3 is shown the best system we could devise for supplying the oil to the bearings steadily, but continuously. The oil is supplied in measured quantities to the tube *A*, Fig. 3, passing down and being absorbed by the cartridge *B*. This was just long enough so that each cone rubbed, and is made up of felt and blotting paper. A measured quantity of blotting paper is rolled and coated with one thickness of felt and is lightly bound round with

thread. This cartridge is made just a push fit into the body and also just a clearance on the spindle. These precautions we found to be necessary, otherwise the charge of oil was almost immediately drawn up to the top and for a short time flushing the top bearing and leaving the bottom oilless.

By supplying the oil to the bottom of the cartridge we found we no more than balanced the leak of air past the spindle and the consequent upward tendency. This tube *A* was tried first in the top, then at the middle, and lastly as illustrated, from which we got the best results.

Tapping to a Shoulder

By Oscar Johnson

The accompanying sketch illustrates an automatic tap, which was made to tap to a shoulder in the turret lathe. We have always used solid taps for the purpose, but on account of jamming the taps up to the shoulder and breaking them, or shearing the pin which keeps the tap from turning, we decided to make something to remedy that trouble that would require no delicate setting.

In the drawing, the pins *A*, which extend through the flutes of the tap strike the shoulder first as the tap is fed in; and as the tap continues to feed, the pins push the collar *c* off the key *B*. As can be seen the collar has two lugs on the end, which fit in a slot cut in the end of the tap, the pins push the collar far enough to clear the key *B*, but the lugs are never clear of the slots and the top and collar revolve with the work.

The pawl *D* is forced down as the collar revolves with the work on account of the back side being tapered, but as soon as the lathe is reversed the pawl catches in the keyway and the tap backs out. The spring pushes the collar back to its original position. So the tap will feed to any depth before tripping.

The Chilean Market for Machine Tools

By Alfredo Prince

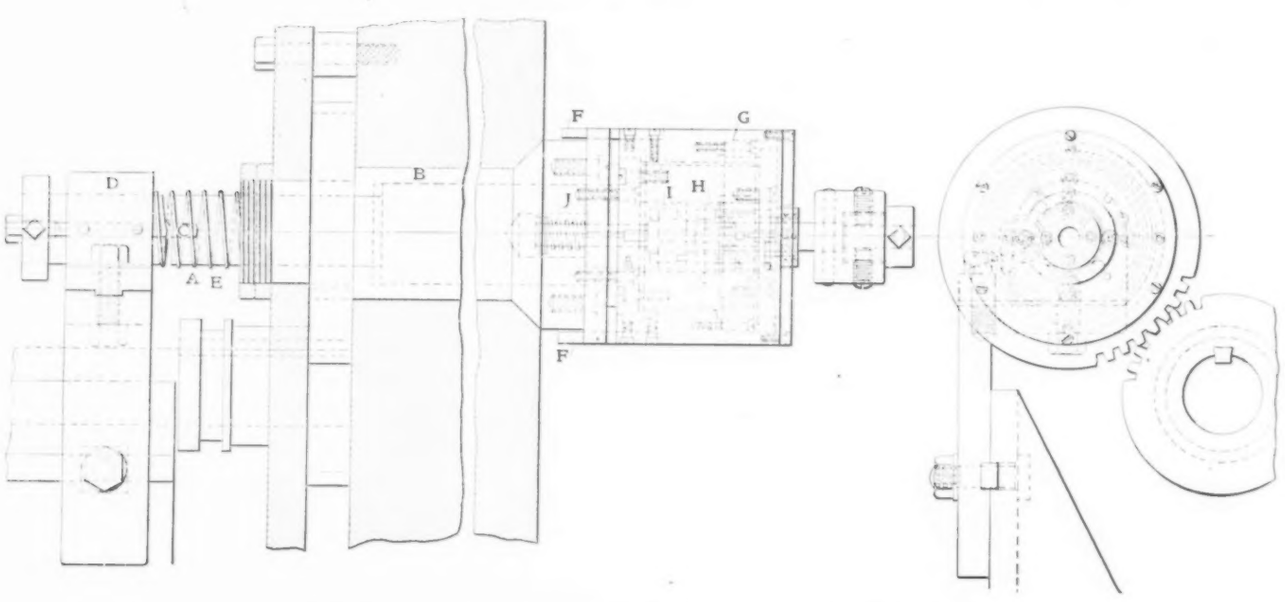
Why do the American machine-tool builders overlook the Chilean market? All the machine tools here are of the most antiquated type, as no doubt our friend Dixie could tell if you asked him, and the machines that are being bought are still on the same lines as those of 50 years ago. The average Chilean shopowner is not a speculative man and will not "buy a pig in a poke" under any consideration, but when he *sees* anything he wants it right off. To sell a machine here one must have one of them to show to the possible customer, and not only show, but make a demonstration of what it can do. Machine-tool builders should have a practical demonstrator and should advertise in Spanish in the local papers.

There is no market for heavy tools, as there are no heavy forgings to machine. The only large machines are driving-wheel lathes in the railway shops. Neither is there any market for manufacturing machines, such as automatic or turret lathes, but there is a market for all kinds of machine tools for repairs of machines used in local industries and in shipping, as every steamer that touches here brings her little job along with her. Medium and small lathes from, say, 10 to 24 inches, could be sold without difficulty over their English competitors, which, I think, are made specially for Chile, as I have seen nothing like them elsewhere. They have no attachments whatever. Sensitive drills I have not seen here. Nearly all small-sized drilling machines are of French make and have a horizontal fly-wheel on top of the spindle, which is fitted with a square hole for the drill, and one must be a first-class marksman to hit the center-punch mark with them, as the drill wabbles all over the place.

Planers also could be sold up to, say, 72 inches, more or less, and radial drills having four- or five-foot arms. Shapers of 12-inch stroke and all kinds of time-saving attachments, such as expanding mandrels, etc., would find a good market. A simon-pure machinist would not recognize the mandrels used here. I had one of Le Count's make some time ago (someone has stolen it since) and I found one of the boys trying to use it for an expanding reamer.

Milling machines are thought here to be luxuries for high-class shops, and to be too full of gilt and gingerbread for every-day use. Mechanics here handle a cutter as if it was made of butter. I do not have a miller, but I have several B. & S. cutters that I use in my lathe, and when one of the boys lets one fall he looks like a criminal, thinking it as frail as a piece of glass and expecting it to break into pieces. I think the milling machines would be popular here if they could be shown at work, as well as simple cutter-grinding machines of moderate cost. One sees, now and then, a hardware store with some Morse taper-shank drills in stock, but there are no drill presses fitted for them, the square-hole spindle being universal on the French drill presses, and this class of drills is unsalable.

Casilla 571, Valparaiso, Chile.



A TAPPING ATTACHMENT APPLIED TO AN ACME AUTOMATIC SCREW MACHINE

An All-geared Headstock

By T. M. Lowthian

The latest design of all-geared headstocks as made by Messrs. Hulse & Co., of Manchester, England, is shown in Fig. 1. Figs. 2 to 5 are diagrammatic sketches for explanatory purposes only. This design is made in three sizes, 12-inch, 15-inch and 18-inch hight of centers; the illustrations showing the 12-inch size. It is adaptable for their standard high-speed lathes and can be made to fit existing lathe beds when necessary.

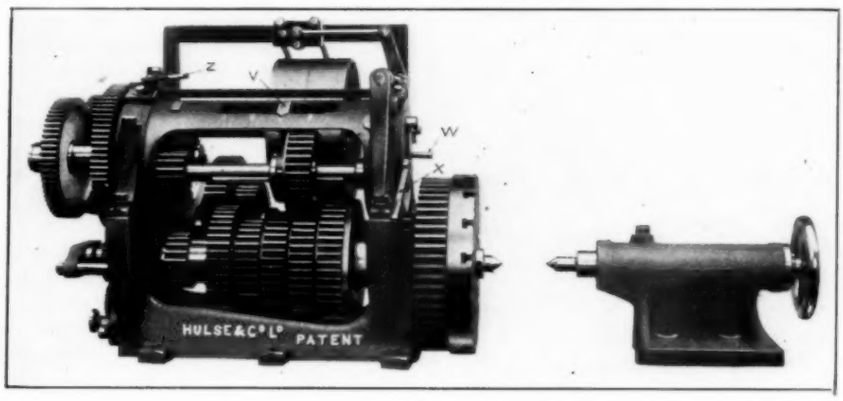


FIG. 1. AN ALL-GEARED HEADSTOCK MADE BY HULSE & CO., LTD.

It is driven by a constant-speed pulley as shown, or it may be coupled direct to a motor. It is arranged with one single and two triple gears and has a total number of different speeds which are in geometric progression.

Eight of these speeds are obtained through the single and 16 through the two triple gears. All of the gears except those actually in use are out of gear which, considering the high speeds, reduces the noise and wear to a minimum; on the eight highest gears the drive comes direct to the faceplate wheel.

Referring now to Figs. 2 to 5, which show, respectively, a front elevation, plan, end elevation and part sectional view, 1 is the fast headstock body, 2 the fast and loose pulleys on the driving shaft $2a$, 3 and $3a$ are two changes of spur gears changed by sliding the wheels (and not with sliding key as shown); the handle m is provided for this purpose. The mating gears for 3 and $3a$ are on the end of the second motion shaft $3b$ which is supported at its outer left-hand end by a fixed bracket, and at its inner end by a bearing in the left-hand end of the tubular frame h. This tubular frame can be rotated in its bearings $1a$ $1a$ in the headstocks 1 by means of the handle h. On the inner end of the shaft $3b$ within the frame h is keyed a pinion d which gears with a second pinion d of the same size keyed to a third motion shaft $3c$ carried in bearings which are placed eccentrically in the frame h.

It will be seen that as the frame h is rotated about its center by the handle h_1 these two pinions d d will always remain in gear, one having a planetary path round the other. On the third motion shaft $3c$ is a spur wheel d_1 arranged to slide along $3c$ by means of the hand wheel d_4, rack pinion d_3 and rack d_2, the latter has a projection upon it which engages with a groove formed in the boss of the sliding wheel d_1. By these means wheel d_1 can be brought into gear with any one of the four wheels k_1 to k_4 on the lathe spindle. The taper pin $1b$ locks the frame h in any of its four radial positions.

By this method the eight single gear speeds are obtained; these are doubled and trebled by two sets of sliding back gears $l_1 l_2$ and $l_3 l_4$ of the ordinary kind. The latter set drives direct onto the faceplate. Thus there are in all 24 different speeds.

Each of the wheels k_1 to k_4 has a thin plate ring attached to one side to engage a similar ring on the wheel d_1 so that when changing from one to the other they can never get too deeply into mesh.

It will be noticed that the construction as seen in Fig. 1 differs in several details from that shown in Figs. 2 to 5. The latter represent the first design gotten out. The principal alterations are as follows: Wheels 3 and $3a$ are made to slide out of gear so that only one pair is running in gear at the same time. The hand wheel d_4 and its connections have been replaced by a handle w (see Fig. 1) which rotates a quick pitch screw. One turn of w gives the necessary sliding movement to the wheel d_1. The pointer v denotes which wheel is in gear, so that anyone can tell at a glance what speed the spindle is running at by referring to the speed list which is attached to the lathe bed.

Again, the handle h_1 for rotating the frame h is placed at the right-hand end of the headstock at x, and in place of a locking pin $1b$ is a hand lever z which operates simultaneously a locking pad in each of the bearings $1a$ within which is carried the ends of the frame h.

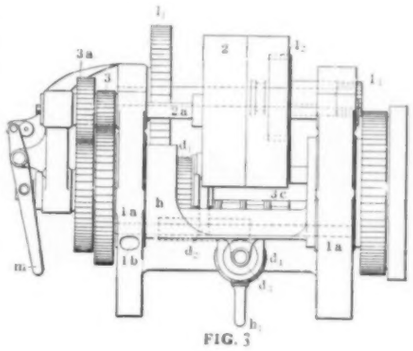


FIG. 3

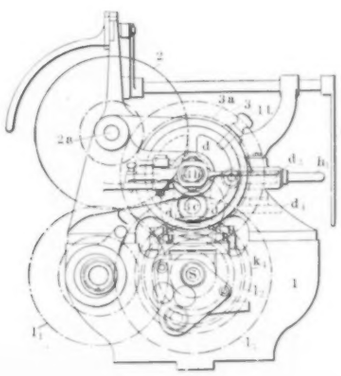


FIG. 4

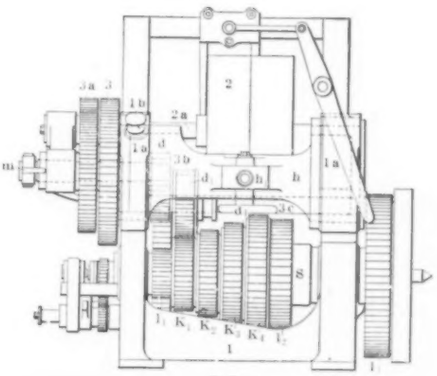


FIG. 2

ASSEMBLY VIEWS OF ALL-GEARED HEADSTOCK

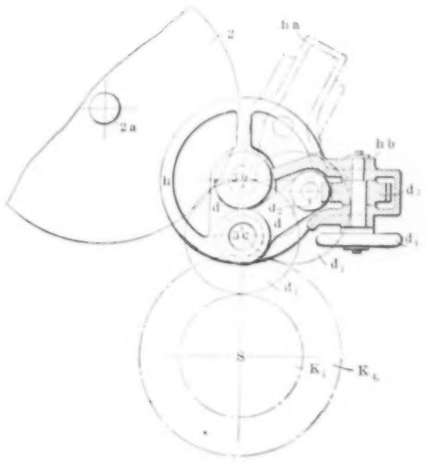


FIG. 5. PARTIAL SECTION OF ALL-GEARED HEADSTOCK

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Punch and Die for Armature Core Segments and a Compound Punch and Die for Stator Core Segments

Figs. 1 and 2 show a punch and die for producing blanks 0.025 inch thick, as shown in Fig. 3, for the armature core of a 500-kilowatt generator. Dealing with the die first, Fig. 1 shows plan and section, *A* is a cast-iron plate, machined top and bottom, *B* are tool-steel segments, machined all over and hardened, and *C* is the stripper plate. As shown, the cutting portion of the die consists of eight segments, each being held firmly in position by two or more hexagon-headed screws inserted from underneath, and all are located and firmly held together in position on the plate by pins and wedges. The pins are driven tightly into the plate and the wedges driven in between the pins and segments. In setting the segments in position the templet—a fac-simile of the required punching made from sheet steel, 3/32 or ⅛ inch thick—is placed in the die, resting upon packing to bring it about level with the cutting edge. When the segments are all set approximately in position and screwed down, then fine and correct adjustment is obtained by means

FIG. 3

FIG. 6

THE WORK

of the wedges. This method of adjustment is very cheap and answers very well; a large number of tools have been designed in this way and all have given satisfaction. Many designers of tools for this class of work deem it necessary to locate the segments in grooves machined in the plate, but this entails much more accurate machining than the simple arrangement here shown. The punch shown in plan and section in Fig. 2 consists of a cast-iron plate *A*, machined top and bottom. *B* is the punch proper; it is made from tool steel in one piece, but is left soft; it is held and located in position on the plate by screws from underneath and pins driven in, and is slightly hollowed out on the top face to within about ½ inch of the cutting edge all around; this is to enable it to be readily peened when wear takes place.

Figs. 4 and 5 show a compound punch and die for producing blanks 0.025 inch thick for the stator core of a 300-kilowatt alternator, as shown in Fig. 6. Plan and section of the compound die is shown in Fig. 4; the description of the other die applies also to this tool, the construction being similar. *A* are the punches for the holes *K*, Fig. 6; they are made of tool steel, hardened and ground. When locating the punches in relation to the other parts of the tool—owing to their being a loose fit in the plate—they can easily be

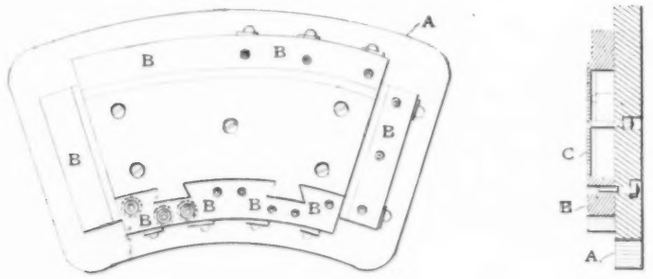


FIG. 1. DIE FOR CORE SEGMENTS

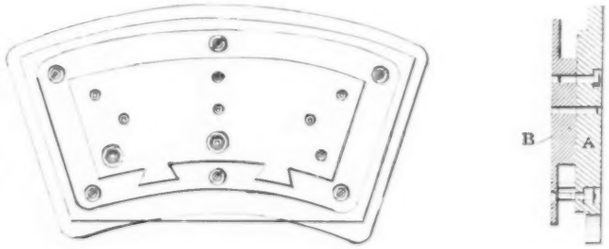


FIG. 2. PUNCH FOR CORE SEGMENTS

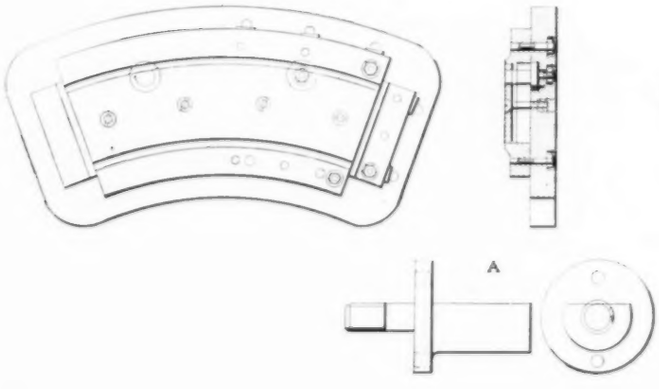


FIG. 4. COMPOUND DIE FOR ALTERNATOR

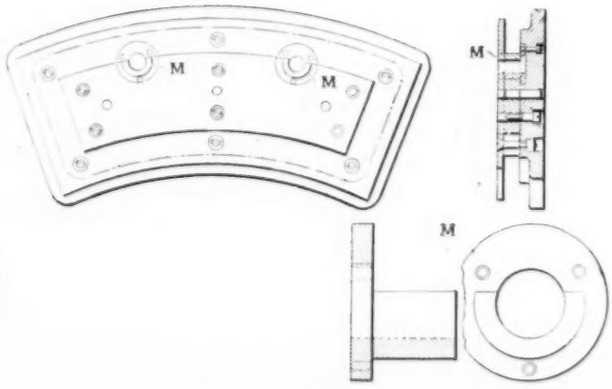


FIG. 5. COMPOUND PUNCH FOR ALTERNATORS

adjusted to coincide with the dies, and when this is accomplished, the nut on the threaded end is tightened up and holes drilled—through the existing ones in the collar on the punches—in the plate into which pins are driven, so holding the punches firmly in position.

Fig. 5 shows plan and section of the punch; the construction is also similar to the other punch described. The dies *M*, shown in detail, are of tool steel, hardened and ground; they are located on the punch and are held in position by screws from underneath, the idea being clear without further description. The segments were machined on an arc-planing attachment in a planer, and ground on another special arrangement.

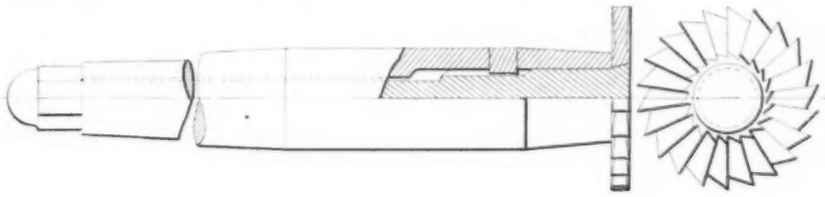
Both the punches and dies are stripped by means of rubber packed underneath the stripper plates in the usual way. The segments were notched at a separate operation on an attachment in a notching press.

I would be pleased to learn of any cheaper design of tool or of any quicker, or more accurate method of producing similar blanks.

Sheffield, England. J. C. Haff.

An Arbor for Holding Slotting Cutters

The drawing illustrates a new method of holding slotting cutters. Formerly these cutters were threaded and held on a screw arbor. The cutter, including hub, was ¾ inch wide; in the present construction the hub is no wider than the cutter. These cutters are made of high-speed steel, therefore we save, in this case, two-thirds of the material, and also the labor of turning off this material, and the cutters run more accurately than when held upon a screw arbor. They are also more readily put on and taken off than with the former method of holding.



ARBOR FOR HOLDING SLOTTING CUTTER

Trenton, N. J. F. G. W.

Tools for the Turret Lathe

The sketches show some tools for turret-lathe work that may be of interest. They are intended for brass work but the principles may be applied to good advantage on other metals as well.

Figs. 1 and 2 are tools for boring nuts preparatory to threading. The chief advantage in these tools is the ease of maintaining the size, as the cutters may be advanced and reground and when used may be replaced at a trifling cost. Fig. 1 is a tool for boring the cast-brass cap nut *A*. *B* is the body with shank *C* to fit the turret. Body and shank are made of a piece of soft steel case-hardened. *D* is the cutter for boring the nut to size for threading and also faces the nut at *E*. This cutter is a piece of round drill rod milled flat on top where it extends into the nut, to provide clearance for chips. The body is also milled off on top for this purpose. The rear end of the cutter is left round where it enters body *B*. The cutter is set obliquely to the center line so that when it is dull it may be advanced and reground on both the front and side. The set-screw *F* holds it in position. *G* is the tool for chamfering the front of the nut at *H*. This cutter is clamped by means of set-screw *I*. The recess in the back of the nut is cored.

Another style of tool is shown in Fig. 2. The work is a cast-brass spanner nut as

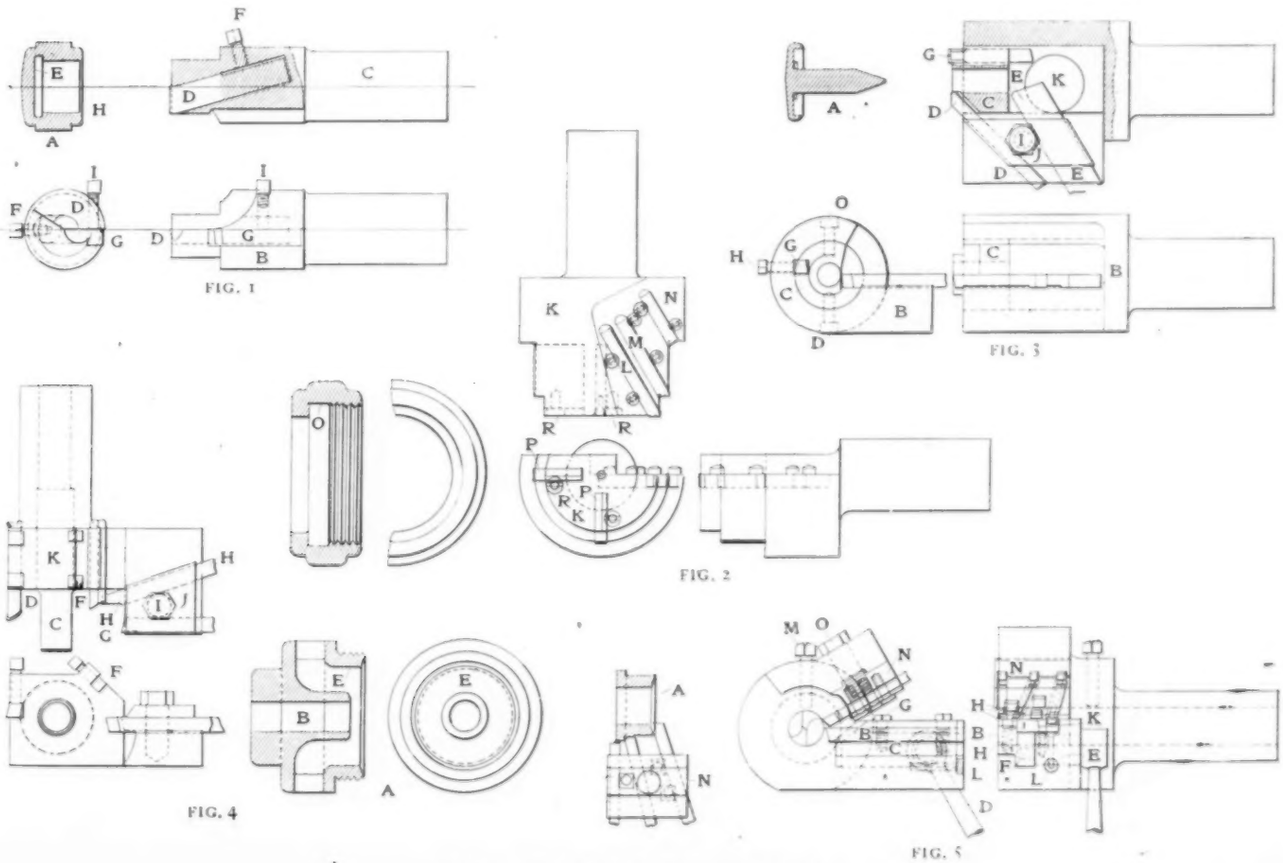


FIG. 1

FIG. 3

FIG. 2

FIG. 4

FIG. 5

SPECIAL TOOLS FOR THE TURRET LATHE

shown at *J*. *K* is the soft-steel body of the tool which is cut away on top to provide clearance for chips. Cutters *L*, *M*, *N* are made of square steel and held in place by fillister-head machine screws. Shims are used at the back end of the cutters to provide against end thrust. Cutter *L* bores the hole through the back of the nut; *M* bores the thread size and faces the inside; *N* chamfers the front for the threads. The recess *O* is cored. *P P* are the guides or back rests held in place by the screws *R R*. When the rests become worn they can be set out by shimming behind them and reground. The rests are tool steel hardened; for convenience in grinding the centers are left in.

While the sketches show the tools right side up we find it advantageous to turn the whole tool half way over or upside down, as this allows the chips to fall out more easily.

Fig. 3 is a box tool for turning the brass casting shown at *A*. This casting is a combined oil-cup feed-screw and cap. The body of the tool *B* is cast iron and is one piece with the shank. It is bored centrally to receive bushing *C* which is of tool steel hardened and ground. The inside is the size of the straight body of the nut *A* (which is afterward threaded). The bushing is held in place by screws as shown. The cutter *D* cuts the piece to size for the threads and also faces the lugs on the underside of the cap, the bushing *C* being cut away to provide for it and also to give clearance for chips. The formed tool *E* finishes the point of the piece. The tool *G* bores and faces the inside of the cap. The bushing is milled out to receive this tool and the set screw *H* holds it in position. The cap screw *I* and plate *J* hold the tools *D* and *E* in position. The tools are set in grooves milled in the body in order to preserve alinement. *K* is an opening to allow the chips to fall through.

Fig. 4 is a gang tool for finishing the cast-brass valve cap shown at *A*, Fig. 4. This tool shows the use of the guide pin for supporting tools. The first operation is to drill the hole *B* for guide pin *C*. The boring tool *D* merely trues up the inside at *E* sufficient to remove the scale so that the tool *F* will make a good clean seat. The tool *G* turns the outside diameter for the threads. Tool *H* faces the end and chamfers the end for the threads. Thus the tool finishes the inside and outside at one operation, with the exception of drilling the hole and threading. Set-screws are used to secure the tools *D* and *F*. *G* and *H* are secured by the cap-screw *I* and plate *J*. The body *K* is cast iron; the guide pin is tool steel hardened. All of the tools are square steel and *D* and *F* are secured in position by setting in grooves milled to receive them.

Fig. 5 shows a tool for making the packing gland shown at *A*. As this gland is made in several different sizes it was desirable to construct a tool that would, if possible, handle all sizes. With this in view the tool shown in sketch was designed. The front view shows the position of the tools. The turning tools are hung from the projecting top of the body. *B* is the cutting-off tool carried in the slide *C*. The handle *D* operates the tool slide through the shaft *E*, which has an eccentric pin on its end at *F* which travels in a vertical slot in slide *C*. The tool *B* is clamped in the slide by cap-screws *G G*, the slide being sawed almost through at *H* so as to form a clamp. *J* is a plate which acts as a gib for the tool slide and is held by means of two countersunk machine screws *K*. The screw *L* holds the shaft *E* in position. The drill is secured by means of the set-screw *M*. *N* is the tool block or gang-tool holder. This is fitted to the body by tongue and groove. The cap-screw *O* secures it in place.

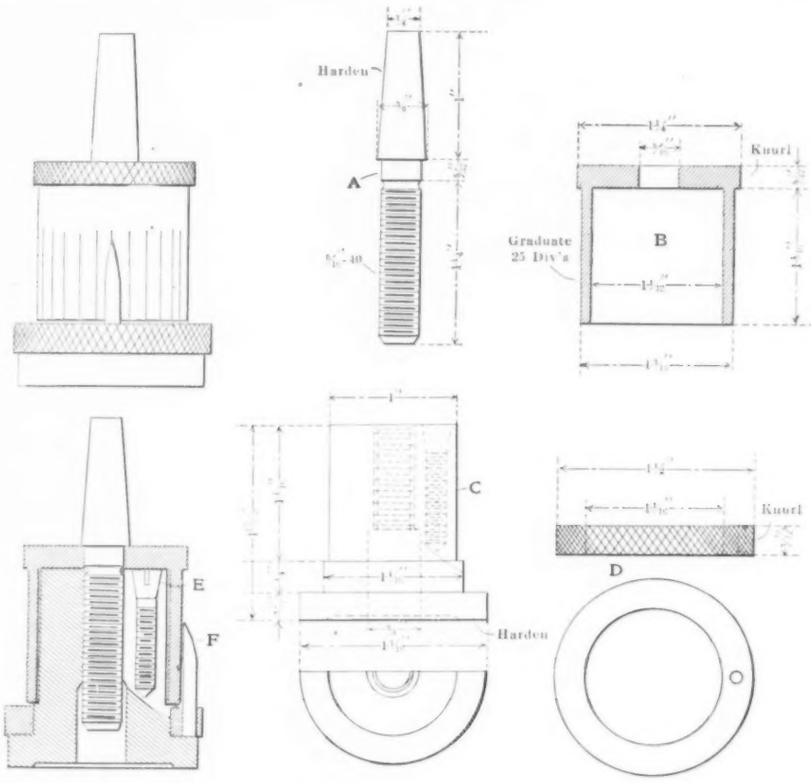
A drill and gang of tools are required for each size of gland, this being all the extras required. With this tool the glands are made from bar brass and several can be cut off at one chucking, as the overhang from the chuck does not interfere with the working of the tool; and as only one station of the turret is used, considerable time is saved in moving the turret backward and forward. In using the tool the turret is advanced sufficiently to complete all of the turning operations; then the handle *D* is pulled down. This cuts the gland off completed. It can be removed with the fingers, but ordinarily on account of its being rather warm a hook is used. Of course using a drill for a guide pin is not always good practice for accurate work, but in this case accurate work is not required.

W. T. H.

St. Louis, Mo.

A Testing and Setting Tool

The tool illustrated in the accompanying drawings has many points in its favor as a testing device. It is simple in construction, and can be made in a short time by anyone who has access to the lathe. Its compactness places it as a strong competitor to the indicator, and while it cannot take its place in a certain line of work, it makes a much handier tool for the general run of testing and has the advantage of being suitable for use in setting planer and such tools.



A TESTING AND SETTING TOOL

It is built on much the same principle as the head of a micrometer caliper. The four main parts are the screw *A*, the thimble *B*, the barrel *C*, and the indicator ring *D*. The principal dimensions are given so that anyone who wishes may, by following them, construct one for his own use.

The screw is threaded 40 threads per inch and by graduating the thimble into 25 divisions we obtain setting by thousandths of an inch, fractional parts of the thousandth being obtained by guess, or if finer readings are desired, the space between the lines may be sub-divided into halves and quarters. The screw is made of tool steel and the head hardened. This latter is done to reduce wear and to in-

sure against burring when in contact with the sharp points of cutting tools.

The thread is tapped in the barrel. The hole is then drilled and tapped for the screw *E* and the latter is fitted. The barrel is then slotted with a thin screw-slotting cutter. The initial strains in the material of the barrel will cause the slot to close slightly upon the cutting out of the metal in the slot. The screw *E* is then screwed into place and by means of the conical head, the slot is opened a little, thus enlarging the tapped hole slightly. In this condition the thread on the screw is fitted to the tapped hole in the barrel so as to turn rather snugly. The object of this is to allow a slight amount of take-up in the nut, which is to be accomplished by unscrewing *E* slightly and depending on the elasticity of the material to close the nut up on the threaded portion of the screw, restoring the desired tension. The length of thread as given ought to be ample to guard against excessive wear and, in fact, the wear should be very little throughout years of use, if both thread and nut are in good condition at the start.

The range of adjustment is not great in this instrument and the uses to which it is put require but little range, the adjustment in each case being but a few thousandths.

Instead of marking the circles on the barrel to indicate the number of tenths of the inch or turns, as is done in the case of a micrometer caliper, the pointer *F*, attached to the ring *D*, is used. This allows of the thimble being rotated until the proper position of the head is reached, and then the pointer is set at zero, so that comparative readings may be made with other surfaces to be tested or other positions along the arbor or shaft. The ring for this reason is made an easy fit on the shoulder of the barrel. If desired, a small set-screw may be tapped into the ring or collar to be used in locking it, in order to prevent shifting of the pointer in the changing of the instrument from one position to the other.

It hardly need be mentioned that the thimble is pressed on the screw to prevent turning. The bottom or base of the barrel should be hardened. All details are ground and finished to suit the judgment of the maker. The main point should be to obtain a smooth working screw and the hole in the barrel should be square with the base, which is easy to obtain by grinding and lapping. The head of the screw should also be lapped to a smooth surface and flat or slightly crowned.

The uses to which this tool can be put will astonish the owner, and as it is not so delicate an instrument as the sensitive indicator, can be handled with greater ease. The user of this instrument requires a good sense of touch, but most men who have use for such a tool have acquired the requisite skill by the use of other devices such as the caliper. In fact a good many mechanics would place more confidence in results obtained by the use of such a tool than they would in those obtained by the indicator where the element of touch is not taken into consideration.

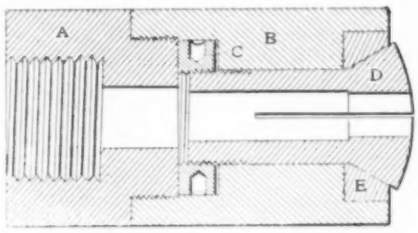
DYNAMIC.

Montreal, Quebec.

Draw-in Chucks for the Engine Lathe

The illustration shows a handy arrangement whereby draw-in chucks can be used on the engine lathe.

The piece *A* is made of cast iron fitted



A DRAW-IN COLLET FOR THE ENGINE LATHE

to the nose of the lathe. It is threaded to fit the piece *B* which is also of cast iron. A recess is left in *B* at *C* for the capstan nut *C*, which is threaded to fit the ends of the draw-in collets *D*. The side of *B* is slotted so that a pin wrench can be used on the capstan nut *C*; this is not shown, but the length of the slot is, of course, governed by the distance apart of the holes in the capstan nut. *E* is a ring of hardened steel which is fitted into the end of *B* and ground in place on the lathe. The usual screw is tapped into *B* to work in the slot in the collet and prevent it from turning. The hole in *A* can be made the same size as the hole through the spindle which, of course, limits the size of bar stock which can be handled.

This arrangement was designed by Edward Board, 619 Filbert street, Philadelphia, and is in use on all the lathes in his shop where I saw it.

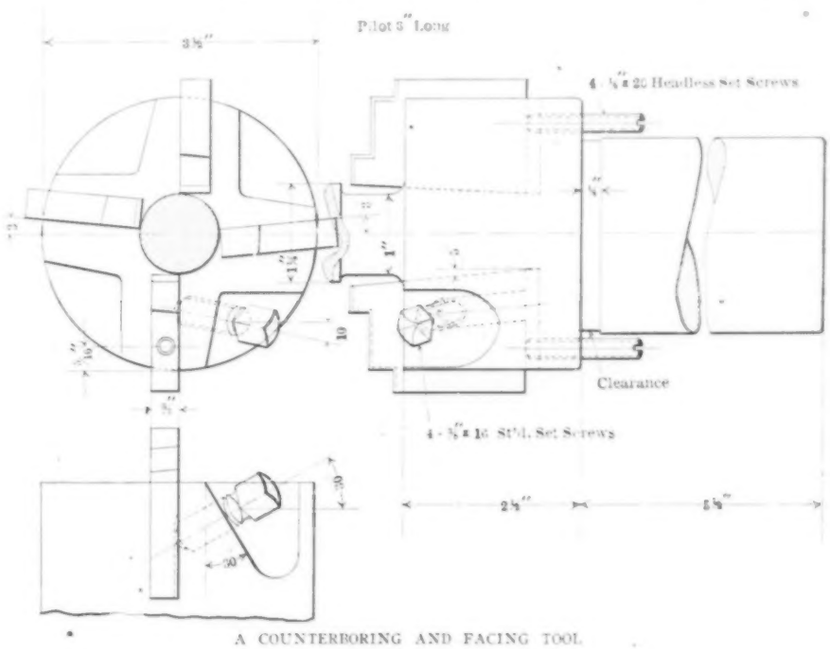
New York. E. A. DIXIE.

A Counterboring and Facing Tool

Some time ago, in machining up a lot of drop forgings, we had a great deal of trouble in obtaining a smooth finish on the pieces, due, it turned out, to the chattering of the finishing tool. This was a four-blade inserted tool, much like the one shown in the sketch, except that the blades were all radial.

The drawing shows how we overcame this difficulty, two opposite blades being set off the radial line by 3 degrees, one of them ahead of the center and the other the same amount behind. Another feature of this construction is the setting of the screws at a double angle, giving them a tendency to press the cutters downward and toward the center as well as to hold them firmly against the retaining back face. The small headless screws are merely for adjustment in grinding, and to prevent the cutters working back. Take up for wear is provided by the 5-degree taper of the slot in which the cutters run.

The construction is very simple and



A COUNTERBORING AND FACING TOOL

efficient, and though it can doubtless be improved upon, it served to overcome our trouble very well. M. R. KAVANAGH.

Detroit, Mich.

The tin production for 1907 was 98,700 tons; the consumption, 101,100 tons. In the latter participated the United States with 39,700, Great Britain, 20,500, and Germany, 15,070 tons.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

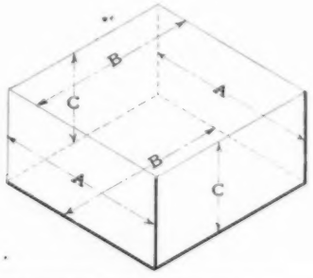
Block Gages for the Shop

The article by Geo. W. Howe, at page 403, relating to size blocks is interesting. If every toolmaker could have a set of such gages he would save time as well as avoid mistakes. Certainly every machine shop should have a set. There need not be many of them for ordinary shop work, and the cost is practically nothing when the results are considered.

Several years ago the firm I was with received an order for a number of automatic machines, to be built from drawings furnished by the purchasers. These machines were complicated and the measurements on the drawings were in most cases in thousandths of an inch. It was evident that we would have to use something better than scale and calipers, which we had up to that time relied upon, if we were to live up to the specifications. I was running the planing job, and as the work required a lot of planing, it seemed to be up to me to find a way to do it accurately. The shop did not have a surface grinder at that time, so all the gages that I made had to be left soft. However, I made a set of blocks that were fairly accurate, and we got through the job satisfactorily. I then made a set of standard blocks that would give me sizes from ½ inch to 3 inches, inclusive, by sixteenths. These we used several months on our regular work, and although like the first ones made they were soft, still they helped us in getting our work to go together with less trouble, than when we had to work in the old way. Later, the superintendent had a good set made of tool steel, hardened, ground, and lapped to size. Every room was furnished with a set of these gages in a neat box, and they are now in constant use, and have been for many years. I have never seen a shop furnished with a set of gages that I thought was quite as convenient as these blocks. The sizes are given in the accompanying tables. The blocks in Table 1 have all sides finished accurately. Those in Table 2 have only two accurate dimensions. These are *B* and *C*, and only the corresponding sides are stamped. The blocks in Table 3 have only one accurate dimension, namely, *C*, hence the length and width are not stamped on them.

There are twenty-three blocks in the set, and for the demands of the ordinary shop they will fill all requirements. In any machine shop where twenty or more men are employed, these tools will more than pay for themselves in the first six months. Their use eliminates the difference between the feel of calipers in the hands of two different men, and no workman will be able to tell his foreman that his calipers must have shifted. Work can be turned or planed in separate parts of the factory simultaneously, and will go together without the necessity of workmen running back and forth to try the parts together.

Worcester, Mass. L. F. CHARLES.



Number Required	A	B	C
One	3″	2¾″	2⅝″
..	2⅝″	2¼″	2 1/16″
..	2½″	2⅛″	2 1/16″
..	2 5/16″	2″	1 15/16″
..	1⅞″	1 15/16″	1 13/16″
..	1 7/16″	1¾″	1 11/16″

Table 1
All Sizes Ground accurately and Stamped.

Number Required	A	B	C
One	1⅝″	1⅜″	1 1/16″
..	..	1½″	1 1/16″
..	..	1¼″	1 1/16″
..	..	1⅛″	1⅛″
..	..	1 1/16″	1″
..	..	15/16″	¾″
..	..	11/16″	⅝″
..	..	9/16″	⅜″
..	..	½″	½″

Table 2
Sizes B and C Ground accurately. Length A not to be Stamped on Blocks.

Number Required	A	B	C
One	1⅝″	⅜″	1/16″
..	..	⅝″	1/16″
..	..	⅛″	⅛″
..	..	5/16″	1/16″
..	..	5/16″	¼″
..	..	¼″	5/16″
..	..	¼″	⅜″
..	..	¼″	3/16″

Table 3
Size C Ground accurately. Length A, and Width B, not to be Stamped on Blocks.

A SET OF BLOCK GAGES

Lard Oil or Soda Water

Under the above title on page 622, Louis Glaser gives his views on the subject, and I practically agree with him, except in one respect, I do not think it is best to boil the oil and soda water together. I know it is the usual practice where the two are used together, but it is the cause of most of the clogging of the valves and pipes where a piping system is used. Of course where each machine pumps its own supply, or the mixture is squirted on the work from an oil can the clogging effect is not so noticeable.

In making "soda," or soap water it isn't necessary that fresh lard oil be used, as the action of the alkali causes the impurities in it to settle to the bottom of the tank together with the other dirt taken up from the work.

In one shop where several hundred gallons of soap water was in constant use in their pipe system, all the lard oil used was taken from a battery of hand screw machines after the oil had become too "dead" for further use in them.

These machines were used to cut threads on very soft machine-steel shells. The threads were cut with a spring die, 1¼ inches in diameter, 30 threads to the inch, and the lard oil used cost the firm in five-barrel lots, just 40 cents a gallon. This oil was absolutely the only thing that could be found that would give a satisfactory thread on the job just mentioned.

When the oil was black and useless it was put into the soap-water tank, about two or three buckets of it being used to a barrel of clear cold water, to which was added a small can of Babbitt's lye (potash). Hot water or boiling was absolutely forbidden, and the resulting mixture, after it had been churned through the pipes by the pump, was a soft, creamy, lubricant that was the best thing for

tapping, drilling, cutting or anything in that line, on ordinary machine steel, that I ever saw. The pipes never clogged and all that was necessary was to keep up the right amount in the tank and clean the dirt out of the bottom of the drain tank occasionally.

One could take a little of the soda water sold for such work, and take a cut, using it as a lubricant and then use this mixture and the difference in the smoothness of the cut and the way the machine pulled was a wonder.

Decatur, Ill. ETHAN VIALL.

An Automatic Screw Machine Recessing Tool for the Back of Nuts

The necessity of a floating holder for this tool as advocated by J. V. H. at page 292 can arise only from the following causes: Referring to Fig. 1 of his article, either it is impossible to bore the hole *D* true with the shank of the toolholder, or else the holes in the turret are not in line with the running spindle of the machine. In the first case, as it is possible to bore this hole true, the addition of a floating holder is an unnecessary expense as well as being bad practice. All tools should be made with a view to eliminating as far as possible any risk of breakage through careless setting on the part of the operator. The very fact of this holder being adjustable, makes it possible to set the tool out of center, while with a fixed bush and the hole *D* bored true this is impossible. In the event of the turret holes being out of line with the spindle, the obvious thing to do is to locate the defect and then remedy it. In our shop, using one of these tools with a fixed bush, we have made upward of 20,000 ¼-inch Whitworth standard brass nuts without a break. The time taken for making these nuts was 14 seconds each. The deflector shown at page 292 is a decided improvement, and having adopted it I must thank J. V. H. I have used this tool on the Simplex machine both with and without a deflector. The brass coupling nut Fig. 1 was made without using one. The order of operations was: first position, drill, counterbore and countersink with the tool, in Fig. 2, and form; second position, cut out clearance *A;* third position, tap; fourth position, cut off. The tool Fig. 3 for recessing, is fixed in a small cutter bar fitted to hole *D* in the tool holder. The cutter is made as shown at *B*, so that when swiveled the required distance it is square with the back of the recess. No side clearance is made at *B*, so as the tool slide advances the tool engages on *C*, (position 2) and immediately begins to swivel, thus putting on a gradual cut. The adjustable cam plate which actuates the tool slide on these machines, is a circular plate swinging on pivots, the length of stroke being altered by means of a worm and rack. As will be seen by holding a disk at an angle, this must give an irregular feed, the start and finish of the stroke being slower than the middle portion. This, coupled with the fact of the material being brass, gave the job a nice finish. Fig. 4 which explains itself, shows the deflector being used in making an ordinary brass nut. The deflector is held in position by one of the screws for holding the shaving arm which is removed.

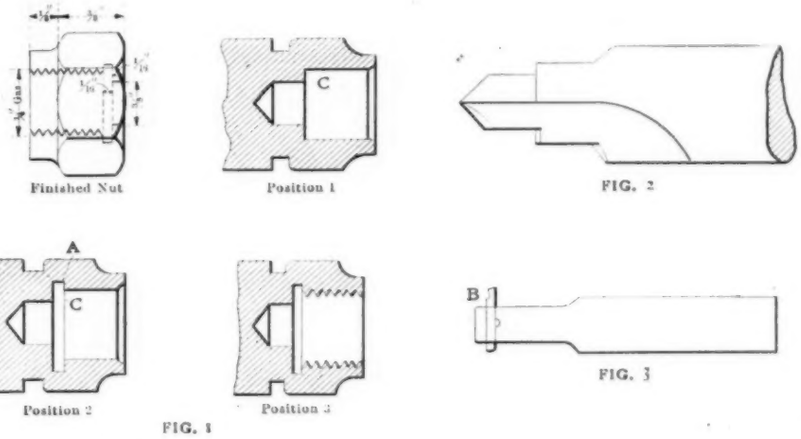


FIG. 1 FIG. 2 FIG. 3

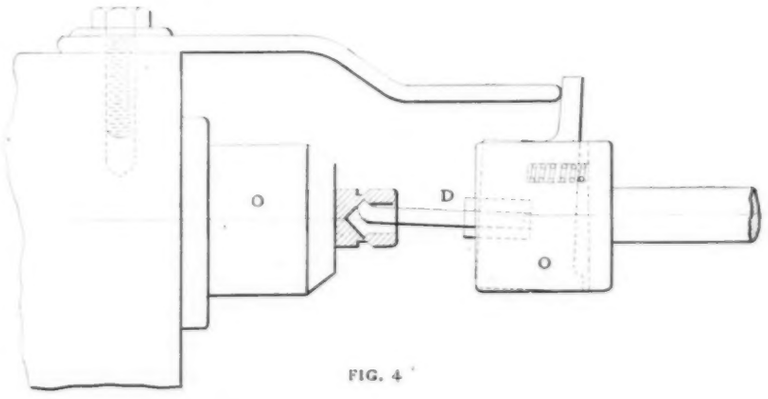


FIG. 4

TOOLS FOR RECESSING NUTS IN THE SCREW MACHINE

Gorton, England. M. E. CHASE.

Piston Rings and Blanks

At page 684, an article on castings for piston-ring blanks interested me.

The iron used is, of course, the principal point in piston rings when the rings depend on the elasticity of the iron, but a great deal depends also on the amount of eccentricity of the ring, the iron, of course, being dense and elastic enough to allow springing the ring in the ring groove of the piston without giving it a permanent set.

The first cost of proper tools, fixtures and patterns is a small item compared with the gain of time and saving of material in making piston rings when they are used in considerable quantities. That "good feeling" that comes from knowing you have something as good as the best is worth considerable in the shop, in the office, and if used intelligently as a talking point by the selling force in the field.

We are now making gas-engine ring blanks very near to finished size, allowing only 1/16 inch all around for turning and boring, the pattern being made with the same eccentricity as the finished ring and has very little taper to allow drawing from sand.

To machine rings we have a plate for the face plate of the turret lathe that can be shifted the proper amount for eccentricity after the blank is turned on the outside, the blank being clamped to the plate in relation to its thick side, and by this method we cast the blanks nearly to size and still have them run nearly true in both positions in machining. The rings are superior because of the small amount of stock removed, and they are being machined at a very low cost.

A method used for making piston rings for steam engines and pumps in vogue at one of the best firms in that line is as follows:

The rings instead of being cast in blanks and cut off are cast singly very near to size, a small amount of stock being allowed for side and outside finish, the ring not being bored, but the inner surface used just as it is cast in the foundry. This makes a very elastic ring which retains its shape under almost all conditions.

A special machine is required to machine these rings which are finished at

one chucking. It also requires a special chuck for each size of ring.

These chucks hold the ring on the inside by a large number of hardened pointed pins that allow for any irregularities in the castings, and also chuck them so they will be eccentric when finished.

The ring grooves in the piston are cut somewhat deeper than they would be if an all-over-finished ring were used to allow for any high spots in the inside of the ring.

The machine has a turret on the tool carriage and carries a roughing and finishing tool for the outside of the ring, and a roughing and finishing straddle tool is used on the inside.

After the machine is set up a boy can operate it, machining rings at a small cost.

By retaining the natural spring of the unfinished surface on the inside of the ring this ring leaves nothing to be desired.

There is no doubt that this method could be used as well on gas-engine rings and be a great improvement over the "finish all over" ring now being generally used.

Madison, Wis. Y. ZIEGLER.

Spirally Fluted Taps

To add to the discussion on spirally fluted taps I will state that for use at screw-machine work on tough, stringy metals such as copper, sheet-metal stampings and steel tubing, tapping fine threads, spirally fluted taps are often the only ones that can be used. In making some dust caps out of scrap sheet metal, the tap was 27/32 inch diameter with 32 threads per inch and 5 flutes were cut spirally right handed, 1 turn in 12 inches. The work while being tapped was run at 500 revolutions per minute and each cutting lip would roll out a chip 6 inches long.

At the Bridgeport Gun Implement Company, on screw-machine work on sheet-metal stampings they use spirally fluted taps a great deal with 5 flutes having a right-hand spiral 1 turn in 12 inches.

Lowell, Mass. PAUL W. ABBOTT.

Cutting V-Threads from one Side

There have been so many articles in the AMERICAN MACHINIST relating to thread cutting in the engine lathe that one would think that all of the little kinks have been taken up. My experience has taught me that setting the compound rest to 29 degrees allows the tool to slightly clean up the back of the thread and not leave a rough thread on one side. The reader will find that with the 29-degree setting he will be able to turn out a far better thread on fine gage or tap work than any other way with a single-point thread tool.

Buffalo, N. Y. F. F. PEASE.

Weights of Bar Steel

The handy formula, or rule, given by Wm. Sangster, on page 587, suggests one which I use for the same purpose; finding the weight of bar steel. My rule is easy to remember, is more accurate than Mr. Sangster's, and applies to any shape of bar. It is: Multiply the cross-sectional area of the bar in square inches by $\frac{10}{3}$. The product is the weight of the bar in pounds per foot of length.

The pounds-per-foot weight of a round bar in terms of its diameter in inches, taking the weight of steel as 480 pounds per cubic foot, is:

$$\pi \left(\frac{d}{2}\right)^2 \times \frac{12 \times 480}{1728} = 2.618\ d^2$$

The corresponding quantity found by Mr. Sangster's rule is:

$$\frac{(4\,d)^2}{6} = 2.666\ d^2.$$

The corresponding quantity found by the rule which I have given is:

$$\pi \left(\frac{d}{2}\right)^2 \times \frac{10}{3} = 2.618\ d^2.$$

As the quantity

$$\frac{12 \times 480}{1728} = \frac{10}{3},$$

my rule is exact if the pounds-per-cubic-foot weight of steel is taken as 480.

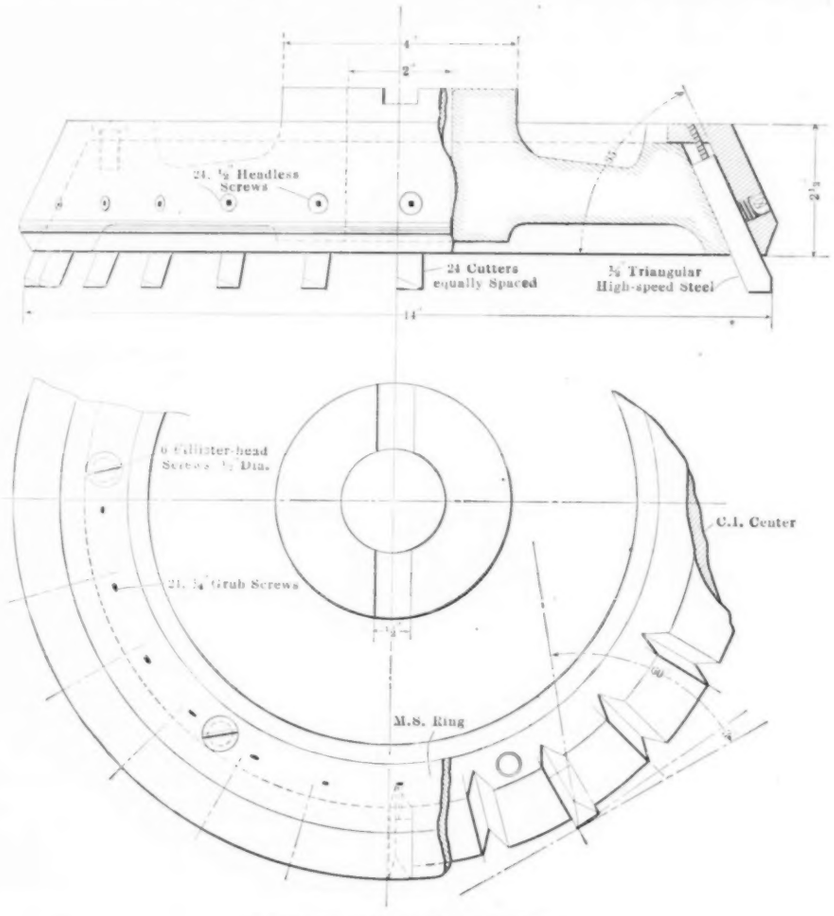
C. E. PARSONS.

Leicester, England.

Profile Steel—An Inserted-Tooth Milling Cutter

The article at page 220 on profile tool steel reminded me of an interesting inserted-tooth milling cutter made from similar profile steel, which I lately saw in use in an automobile works in France.

The idea in this design of cutter is to use profile steel whose section is an equilateral triangle, the face angles therefore being 60 degrees. This is so arranged that one side gives the necessary clearance and the other the requisite cutting angle.



INSERTED-TOOTH MILLING CUTTER

I have made a sketch of the complete head, which consists of a cast-iron center bored out to suit a standard arbor and turned taper on the outside. Fitted over this is a mild steel or malleable iron ring, which is secured by six fillister-head screws. The cast-iron center is gashed on its periphery with a 60-degree cutter, which is thrown out of center, the amount determining the clearance, and into these slots are fitted the triangular blades. These blades have sides of about ½ inch,

and each is secured by a headless screw, a small screw being provided to take the thrust and to give adjustment on account of wear. After hardening and fitting up the teeth are ground up in position.

In the sketch are given a few of the leading dimensions which will show the general proportions. This form of cutter when I saw it in operation was doing exceedingly good work upon aluminum gear cases and engine cases. Its cost is low and upkeep inexpensive.

FRANCIS J. BOSTOCK.

Birmingham, England.

Automatic vs. Hand Turret and Engine Lathe

Referring to the article on page 423 I shall try to show that the automatic is the cheapest in every case. I show sketches of eight samples, which have to be done in lots of 100 each on hand turret, engine lathe and automatic. In each case piece work was used on the lathe by a skilled machinist, and on the turret by a skilled specialist.

The only note on time of handling that I wish to make is that a piece for the engine lathe was cut off and centered in one department and taken to another to be chucked to the lathe; both hand turret and automatic were finished in one department.

I have taken a variety of shapes which will add to the fairness of the comparisons, and on which there was machining enough so that but one automatic was down or idle at a time, the time given being for six machines. This is also fair to the competitors, giving them long cuts so they can take every advantage in changes.

The question of special tools does not come as high as one would think, if the case is fairly met, as a job properly set on the hand turret would take the same tools as the automatic. Form tools are the only special tools required, as drill reamers and counterbores should be standard and universal. On example 6 we had a combination nurl and four-lipped drill and form tool that cost not more than $50, and which were not needed on the other machines.

"To cut costs cut time between cuts" is the slogan of the automatic. No operator of a large hand machine could index or change feeds and speeds or work in combinations of turret and cross slide as fast as the automatic, or in other words, make the fireman do the work.

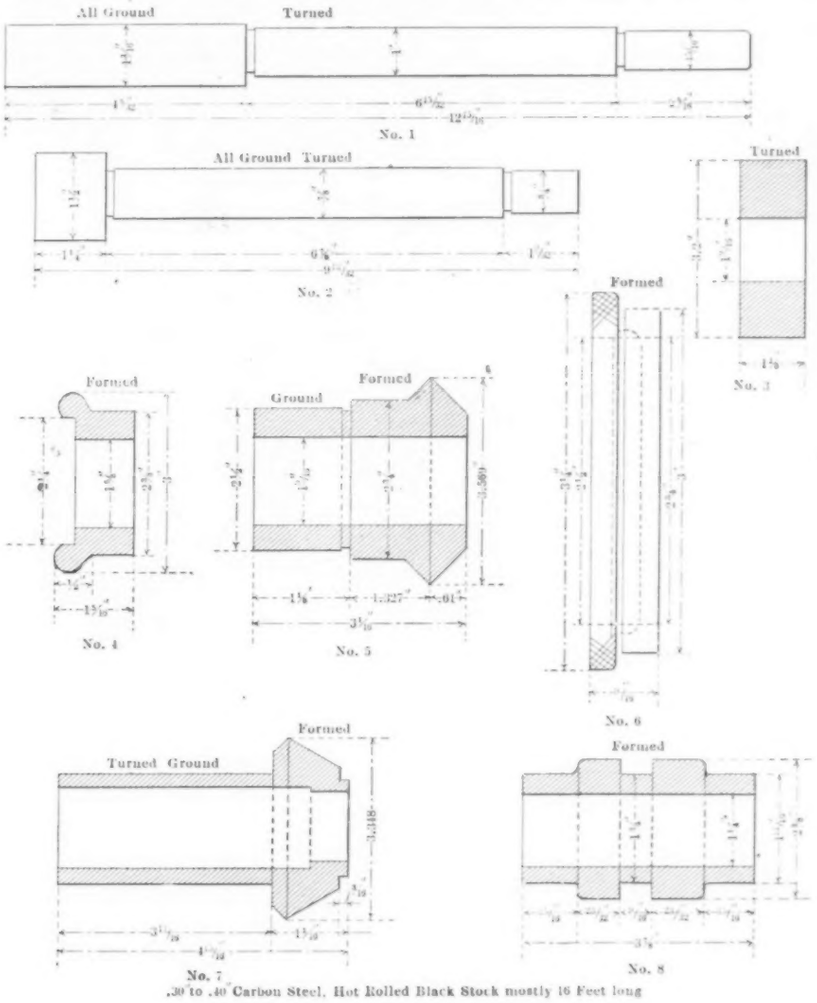
Examples 1 to 4 were made on a 3¼-inch Gridley, 1 and 2 were turned 0.008 inch oversize for grinding, the end finished and nicked, 3 and 4 were finished to size and end faced. Nos. 5 to 8 were made on a 4¼-inch Cleveland, turned 0.008 inch oversize for grinding and formed to size, and one end faced.

Below is the time for each piece in lots of 100 which includes cutting off, centering and chucking.

Example.	Lathe. Min.	Lathe. Cost.	Hand Turret. Min.	Hand Turret. Cost.	Automatic. Min.	Automatic. Cost.
1	25	$ .12½	22	$ .11	17	$ .01½
2	21	.10½	24	.12	18	.01½
3	22	.11	18	.09	9	.00½
4	39	.14½	20	.10	12	.01
5	52	.26	45	.22½	30	.02½
6	41	.20½	30	.15	17	.01½
7	111	.55½	71	.36	65	.05½
8	46	.23	45	.22½	32	.02½

The costs as here shown are for actual outlay for the labor.

Fairfield, Conn. M. I. FRANCIS.



.30 to .40 Carbon Steel, Hot Rolled Black Stock mostly 16 Feet long

AUTOMATIC VS. HAND TURRET WORK

Another Handy Kink for Draftsmen

Under the heading "Handy Kinks for Draftsmen" on page 64 of Vol. 31 you show an excellent device for use in the drafting room by A. L. Campbell. In my opinion this has some defects, as considerable time would be lost in taking out the pencils and replacing them every time they required sharpening.

RULER FOR PARALLEL LINES

The accompanying sketch shows a square which would have none of these defects and may be new to some.

A line is drawn along the edge *a*, the square is slid along and a line drawn along edge *b*. Of course any number of lines could be drawn but the square would require more steps.

Scotland. IRON BURGH.

Here are some interesting figures in connection with the famous Krupp works: During the year 1906 the combined works consumed 2,361,425 tons of coal; there are on the payroll 65,000 men; in the Essen works there are 6500 machine tools in use; 74 hydraulic presses, over 300 stationary steam boilers, 540 steam engines, and considerably more than 700 cranes.

Amherst, Nova Scotia, is supplied with electric power and light generated from the waste products of a coal mine. This is in accordance with Mr. Edison's prophecy, that the future site of electric generation would be at the pit's mouth.

Combined Vertical and Horizontal Milling Machines

This machine should suit the advocates of both types of milling machines as it is built to be used either way without attachments of any kind. It is a heavy machine, having spindles 4½ inches in diameter running in phosphor bronze bearings and having quills No. 25, 7½ inches in diameter by 12 inches long. These have a 6-inch adjustment and are provided with a graduated scale to show their position.

The spindles have taper bearings and wear is taken up by the adjusting nut 22, bearing against the cone sleeve 23.

The drive is through pulley 1, or in the case of motor drive the gear goes on this shaft. Shaft 2 carries gears 3 and 4 which are controlled by handle *A* in Fig. 1, and also drives the sprocket wheel from which the feed box at the base is driven. Power is transmitted from gears 3 or 4 to 5 or 6, depending how the handle *A* is thrown and through shaft 7 drives both the vertical and the horizontal spindles, the former through the bevel and spur gears 15 to 20 and the latter through the spur gear train from 8 to 13. Both spindles may be thrown in or out by handles *B* or *C*, through the clutches shown and the position of these clutches determines the spindle speeds. These changes, with the two-speed countershaft furnished with the machine, give 8 different spindle speeds ranging from 15 to 100 revolutions per minute. Both spindles can be moved in and out by the crank handle *D* which fits on either stud as shown in Fig. 1.

The feed is driven by chain on sprocket 26, this being mounted on a friction sleeve 28 through which it drives shaft 27. This is to avoid shock when changing the feed gears. From here it is transmitted to the gearing in the feed box through the clutch controlled by the handle *E* which simply throws the feed in or out, reversal being secured from the handle *J* at the front of the carriage through the rod *L* which turns a pinion in the vertical rack *M* and throws the clutch between the bevel gears on stud *F*. This drives a gear on stud *G* and the worm gearing which turns shaft *N* and gives the table feed through the bevel gears shown. This rod continues to the front of the carriage and gears to the rod *O* below it in dotted lines, so that the elevation of the knee can be handled by power and these are so arranged that the vertical feed of the knee is just half the table feed. The same train of gearing connects with the cross-feed screw in the center of the knee and is at the same rate as the table feed.

The feed box at the base is of the cone-of-gears type, with the traveling gear moving into the proper gear of the cone. This gives 16 feeds for each speed of the spindle, ranging from 0.48 to 8.9 inches with the slow countershaft speed, and from 0.97 to 17.8 inches per minute. There are also two extra gears on *F* and *G* which give feeds running up to 34 inches per minute.

The column is 84 inches high, 22 inches deep, and 18 inches wide. The knee is 36 inches long, has a bearing on the column of 28 inches, and the width of the face bearing is 22 inches. The saddle which carries the table is 60 inches long, 6 inches deep and has a bearing on the knee of 20x22 inches. The table is also 60 inches long, so that in the central position, it is supported its whole length, has a working surface of 48x18 inches, is 5 inches thick, and has 3 T-slots cut from the solid while all the pin holes are drilled. Arbors are 2 inches in diameter and clutch driven from the end of the spindle.

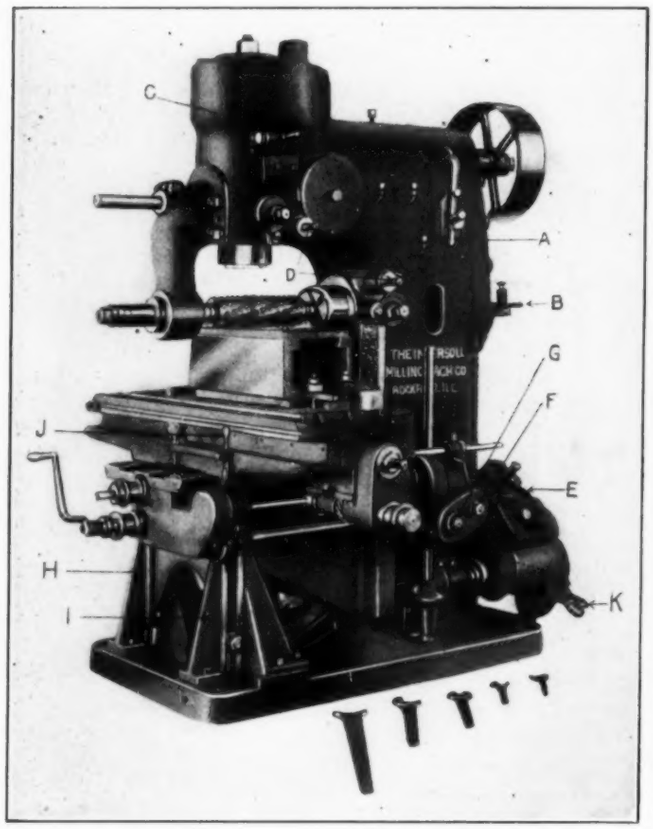


FIG. 1. COMBINED HORIZONTAL AND VERTICAL MILLING MACHINE

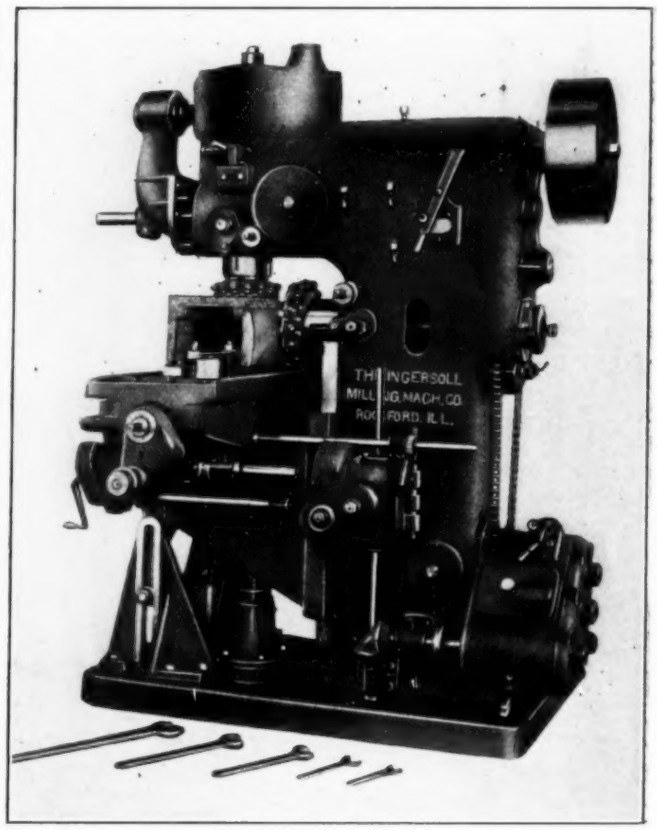


FIG. 2. USING BOTH SPINDLES ON THE SAME PIECE OF WORK

When desired a circular table 16 inches in diameter can be used on top of the table itself.

That it is a solid machine in every way can be seen both from the design and the weight, which is 9700 pounds without the circular table. It is made by the Ingersoll Milling Machine Company, Rockford, Ill.

Most of the so-called aluminum solders disintegrate in a few years. The following composition will be found as satisfactory as any: Tin, 29 ounces; zinc, 11 ounces; aluminum, 1 ounce, and 5 per cent. phosphor tin, 1 ounce. The solder may be applied with the soldering iron or the blow pipe.—*Brass World.*

Tool Making without Drawings

By Arthur Frederic

Samuel Taylor in his article at page 749 makes some remarks about tool making and tool designing, which sound like the old, old story to me. My experience has been that the matter of a fixture with four or five parts, or a fixture with toggle joints, levers, cams, dovetail slides, etc., is largely a question of the competence of the tool designer in the last analysis. Left to himself, the average toolmaker will spend a lot of time getting out something "to do a job" and will usually make "something" which takes longer to operate than a live tool designer will. I have seen very few toolmaker's fixtures in which an effort was made to reduce the number of tightening and releasing devices to save the time of the operator. Again, if your toolmaker makes up the jig or fixtures complete, you are paying a big price for roughing out the castings and forgings at toolmaker's wages, which should be done in the milling and turning departments of the tool room by cheaper men, and this cannot be done if there are no drawings.

The problem of efficient and economical tool design in general requires the attention of specialists, and the ordinary machine tool or mill draftsman who produced that "complicated mess whose production is no greater than could be accomplished by screwing two pieces of steel, properly shaped, to a pair of pliers" has no place in the tool-designing room, except as a detailer or tracer. Actual experience in the production department is as important in the education of a tool designer, if not more so, than his toolmaking experience. The average toolmaker does not appreciate the importance of rapidity of operation of clamping devices, the providing of proper chip and bur clearances, and the vital necessity of semi-fool proof construction on equipment for the interchangeable manufacture of accurately machined small parts. Again, where there a number of operations on one part, the tool designer has carefully to consider working points, and an arrangement of operations, which will enable the part to be produced with the lowest possible production cost, and the minimum expenditure for tool equipment consistent therewith.

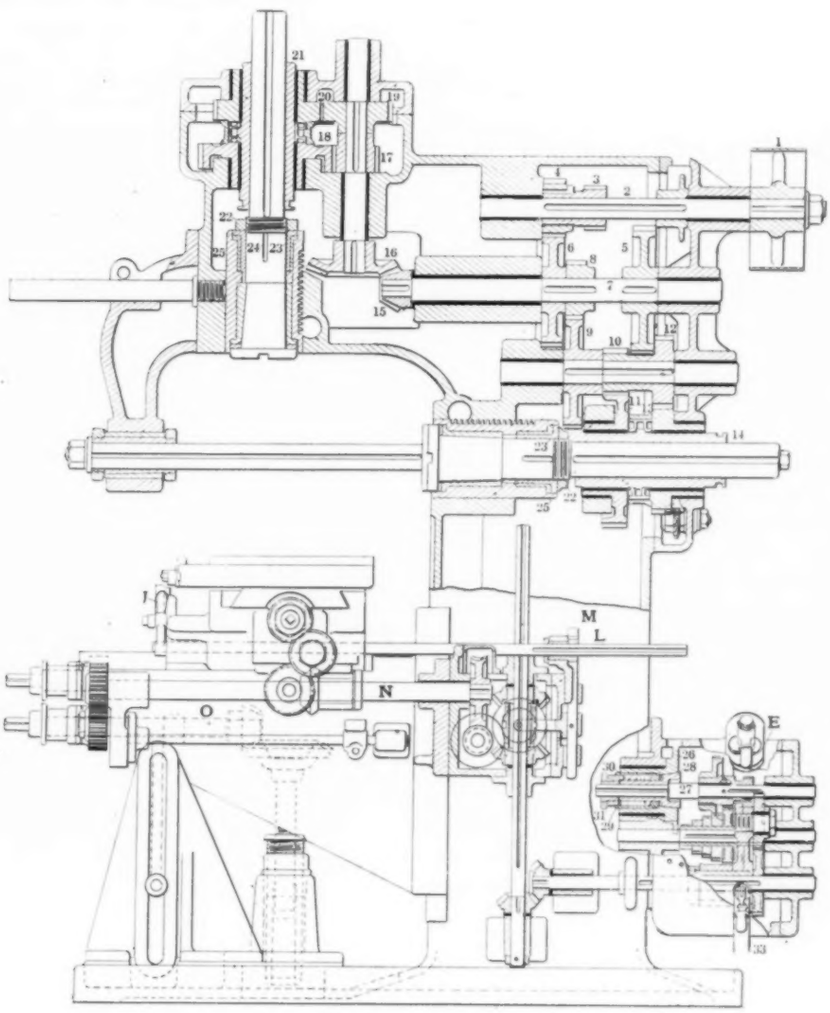


FIG. 3. DETAILS OF THE MACHINE

It has been my experience that the entire fixture, jig and gage equipment for a given part should be carefully worked out in sketch form by the tool designer even before drawings are made for any of it, and under no circumstances, should the happy-go-lucky method described by Mr. Taylor be employed, except in the roughest kind of work. In the case of punches and dies, a proper study of the problem in general should be made by a competent tool designer, and a few standard die-bed castings and punch shanks designed. Then the simpler blanking, bending and drawing dies can sometimes be made up directly from the tool designer's sketches by a diemaker, although even then it is usually cheaper to get the stock roughed out in the roughing departments. The more complicated press work, however, should be designed and drawn before attempting construction.

That "toolmaker who has more than the average designing ability," with a little study of the principle of drawing and some production-department experience, should be making $30 a week, or more, in the tool-designing department, and not waste his time making up the parts of a jig or fixture at 35 cents an hour, which can be done by the man who has not originality enough to design.

An alloy known as ferro-titanium is, says the *Engineering Times*, in the opinion of many of the best known metallurgists, destined to revolutionize the manufacture of the more important grades of steel and iron. This includes not only tool steel, but steel rails, shafts, tires, car wheels, and any article where breakage means loss of human life. In a paper on the subject before the Pittsburg Foundrymen's Association, C. V. Slocum expressed the opinion that such revolution was justified not only by the excellent results obtained, but also by the comparative abundance of titanium in deposits of iron ore in mountain masses. This latter consideration will probably bring the price so low eventually as to be quite of minor importance. The iron ores of the Adirondack range contain high percentages of titanium, as do many of the ore deposits in the States, Canada, Sweden and other localities. About 1890 the St. Thomas Car Company noticed a peculiarity in certain car wheels made for the Michigan Central railroad. They were unable to grind the tread and they obtained an extraordinary mileage from wheels made at the time. This was traced to one of the irons used, which had been made from titaniferous ores. It is exceedingly difficult to break an alloy of steel and titanium by blows.

The production of pig iron during the first six months of 1907 was 13,478,044 tons. The production of the second half of 1907 was 12,303,317 tons.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 1,151,500 *copies of the* AMERICAN MACHINIST. *Our circulation for May,* 1908, *was (weekly, monthly and European)* 94,500.

June 4..... 35,250
June 11..... 19,500

This paper reaches 35,250 *separate readers each month and* 20,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
Machine Work in Steel-mill Machinery	893
A Compact Blueprint Room	896
A Worm Wheel Hobbing Machine	897
Echoes from the Oil Country—The Evolution of a Boring Tool	899
Sizes of Shafts Without Mathematics	900
A Machine for Milling Screw-machine Cams	902
An Inspecting Indicator and a Milling Fixture	904
Circular Beams	905
Turret Tool Holder for the Lathe	906
A Cam Cutter and a Planing Kink	906
Ball Bearings for High Speeds	907
Tapping to a Shoulder	908
The Chilean Market for Machine Tools	908
An All-geared Headstock	909
Practical Letters From Our Readers: Punch and Die for Armature Core Segments....An Arbor for Holding Slotting Cutters....Tools for the Turret Lathe....A Testing and Setting Tool....Draw-in Chucks for the Engine Lathe....Counterboring and Facing Tool	910-913
Discussion of the Previous Question: Block Gages for the Shop....Lard Oil or Soda Water....Recessing Tool....Piston Rings and Blanks....Fluted Taps....Cutting V-Threads ....Profile Steel	914-916
Another Phase of Coöperative Engineering Education	920

Another Phase of Co-operative Engineering Education

We wonder if the possibilities of Professor Schneider's plan of co-operative engineering education, growing out of its thoroughgoing Americanism, have occurred to our readers.

To those who have given attention to the matter, one of the reasons, and perhaps the chief reason, for the success of this country in manufacturing, of the products of the machine shop, at least, is the democracy of the American shop. It may, we believe, be said without fear of contradiction that in no other country, and certainly in no European country, is there any such free interchange between the mechanic at the lathe or bench and the management of the shop as in this, and in no other is promotion from one to the other position so taken as a matter of course. In the countries of western Europe, and more perhaps in Germany than in any other, there is a degree of stratification running through the shops, which, to an American, is almost incomprehensible. The personnel of the management is from a different social stratum from that of the shop force, the former, so far as its technical side is concerned, being recruited, in Germany, at least, almost exclusively from the graduates of technical schools. We are far from belittling the work of shops organized in this manner, and, indeed, the progress of Germany, of which we hear so much, makes such belittling impossible, but at the same time, we believe our home readers will be a unit in approving the sentiment that such men must lack much that is desirable in their make-up and equipment.

Without attempting to particularize, it is, to Americans, self-evident that for the greatest success and the most rapid progress intimate personal knowledge of actual shop work is in many fields essential, and in no field, perhaps, more so than in that of machine-tool construction, in which, unquestionably, the greatest advances of the past twenty years have come from this country. There can be no question of the value of technical education as carried out either in Germany or in this country, but such education without personal knowledge of shop work and shop conditions is not to be compared with the same education combined with such knowledge. Such knowledge of the shop as can be obtained from without or, if you please, from above, is not for a moment to be compared with that which is obtained from within.

Valuable as is a knowledge of analytical methods, it is many times more valuable when combined with that instinctive knowledge and that sure judgment of what is and what is not practicable, that can only come from the actual doing of the work of the mechanic, and this, under the social conditions of Germany, is impossible. The technical school graduate of Germany, or the man who contemplates becoming such, would consider it altogether beneath his dignity to go into the shop in order to learn a trade, and, indeed, it would be beneath his dignity as that term is understood in Germany.

There can be no doubt that under these conditions important advances have been and are being made, but there can be just as little doubt that they lead to a tremendous waste of effort. The spirit of investigation which is fostered in the German technical schools has led to many important results, but it has also led to the undertaking of numerous lines of investigation which have no possible application to the business of machine building. Tests and investigations without limit are undertaken, apparently for the mere pleasure and satisfaction of the work, and the cost of these investigations sooner or later appears as part of the cost of the products. Moreover, this spirit, combined with the well-known German spirit of thoroughness leads to the paying of a great deal of expensive attention to non-essentials in machine construction. It is unquestionably true that in Germany, precision for the sake of precision, and in places where precision is uncalled for, and in some cases is even harmful, is carried out to a degree which must add materially to the cost of the products and to no good purpose.

These features of German practice, about which there can be, we believe, no question, are undoubtedly the outgrowth of the academic training and the consequent academic spirit of the academicians who manage German shops. We are far from saying that American shops are entirely free from the same spirit, the existence of which, so far as it does exist, may perhaps be fairly charged to the exclusive academic training of many of our engineers.

What we wish to point out in connection with Professor Schneider's plan is that it offers a sure path out of this condition of things, and a path which is open to the United States alone. It is, at bottom, the democracy of the American shop which makes this plan practicable in this country, and there could be no better demonstration that we are not overstating this democratic condition than the fact that Professor Schneider has on file 2000 applications from candidates for his entering class of next fall—a number which is twenty times larger than the number of students who can be accommodated in Cincinnati shops.

That this plan will train engineers who will combine theoretical and practical attainments to a greater degree than is possible by any other, is, we consider, self-evident; that the students who pursue this course will comprise the best possible timber from which to make engineers is also evident from the great number of applicants from whom selections are to be

made, and, with these advantages, it has, to us, another, in that it is a good thing which, from the nature of his social structure, the German cannot copy.

We believe Professor Schneider's plan to be the best that has been proposed for the training of engineers; we believe that its application on any considerable scale is possible in this country alone among those whom we may consider as serious competitors; and, as a necessary outgrowth of these beliefs, we believe further that it is largely through it that we may expect to establish and maintain the manufacturing supremacy of this country.

The Engineer as a Man of Affairs

Do engineers as a class appreciate that there is more in life than engineering and money getting? Can we depend upon engineers as a class for sane actions, intelligent far-sighted opinions and skilful guidance in public affairs? Do engineers speak and write sanely on questions of public interest and welfare, especially on those questions which they are best qualified to discuss? Is the individual engineer, as a representative of his class, a good citizen in the highest sense of the term: is he a good fellow-townsman and a good neighbor?

To each of these questions we are forced to answer: No. One fact which points to the truth of this answer is found when we consider the make-up of commissions, boards and committees appointed or elected to deal with public matters. We seldom see an engineer serving as a member of such a body. Its members are usually business men, lawyers or men-of-affairs. We may well ask, why are such men better fitted than engineers for the consideration of broad, vital questions?

Let us consider the training of the lawyer. His training is as highly specialized as is the technical training of the engineer; embracing perhaps, Roman law, English common law, constitutions, statutes, precedents, and so on. All of these are man-made. Similarly, the engineer studies and uses laws; he stands or falls, succeeds or fails in so far as he follows or neglects the laws upon which his profession is founded. But the laws of the lawyer are changeable and man-made, while those of the engineer are the unchangeable laws of the universe. Without in any way drawing comparisons, or seeming to draw them, we believe that engineers are as sensitive to right, truth and honesty as are any class of professional men. Their habit of mind tends toward truth. They are respecters of law. They are in the habit of having their efforts measured by results. Their methods of action are direct and straightforward.

Why then are engineers less qualified to deal with problems in a far-sighted manner than business men or men of affairs? In answer; because the engineers' knowledge is knowledge of things, not of men. As a class they need a wider acquaintance with men and affairs.

The tendency of the times is to belittle the mere money-maker no matter in what field of endeavor he gets his riches. There is at present a movement in our country toward civic righteousness. There is always a demand for men who are willing to spend and be spent for the public welfare. Representative government in this country is still in an experimental stage. One hundred, or one hundred and fifty years, is too short a period of trial upon which to base a statement that our form of government is stable. We admire the actions of our forefathers in having established it; but are we, their sons, doing our part in order to carry on the experiment to a successful conclusion? An engineer who is neglecting any part of the broad duties of citizenship is not measuring up to the highest standard of his profession. When his entire duties are more clearly realized and more diligently executed engineering will come into its own, and will be recognized as the profession which it really is. Direct engineering methods are better than the underhanded ways of the politician; are better than the devious twistings and turnings of the lawyer; are better than the long chances of the financier. Direct methods are needed by the public in the execution of public affairs.

A heavy responsibility rests upon our engineering schools in this connection. It is their duty to combine with the special training of the technologist the broad training of the man of affairs. A few have made a start in this direction, among which may be mentioned the Worcester Polytechnic Institute and the Stevens Institute of Technology. There is considerable discussion in some quarters in regard to increasing the length of technical courses and our technical educators will be far from living up to the requirements of the times if, in lengthening such courses, they do not give proper attention to the necessities of broadening education.

Meeting of Society for Promotion of Engineering Education

The 16th annual convention of the Society for the Promotion of Engineering Education will be held at Detroit, Mich., from June 24 to June 27, inclusive. This will be a joint meeting with the American Society of Mechanical Engineers, which society has changed the usual date of its annual spring meeting in order to meet a simultaneous date. Many important topics are promised for discussion and special features are planned to commemorate the 15th anniversary of the founding of the society.

Personal*

Charles Waterman, formerly with the Providence Engineering Works, is at present general foreman of assembling at the New Castle plant of the Maxwell-Briscoe Motor Company.

C. R. Spare has become vice-president of the American Manganese Bronze Company, and will also act as manager of its works now in course of erection at Holmesburg, Philadelphia.

Charles C. Thwing, sales manager of the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., sailed for England on May 28, and will make a business trip through Europe.

Herbert D. Penny, until recently with the Stanley G. I. Electric Manufacturing Company, Pittsfield, Mass., has accepted a position as designer of manufacturing equipment with the Remington Arms Company, Ilion, N. Y.

S. D. Leland, until recently with the United Shoe Machine Company, of Boston, and for the past 23 years actively engaged in the management of manufacturing plants, has accepted the presidency and general management of the Manufacturing and Engineering Company, of Boston, Mass.

Fred A. Johnson

Fred A. Johnson, president of Gisholt Machine Company, of Madison, Wis., died in Denver, Colo., May 26. He was born in Madison, Wis., 1862, and was therefore but 46 years old at his death. At the beginning of his career he attended the University of Wisconsin for a time with the class of 1884, having entered the mechanical engineering course in 1880. His desire for practical experience, however, led him to enter the agricultural-implement shops of the Fuller & Johnson Manufacturing Company, of Madison, in which company his father was largely interested. He spent a number of years with this concern, rising to the position of assistant general superintendent. On the organization of the Gisholt Machine Company, in 1887, he joined with his father and brothers, devoting himself to its interests. In 1901 he became president of the company. He took an active part in the management of the business and spent several years in Europe in the interests of the company. Since 1904, however, owing to ill health, he had been unable to attend to business. He was a member of the American Society of Mechanical Engineers and an associate member of the English Society of Mechanical Engineers.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

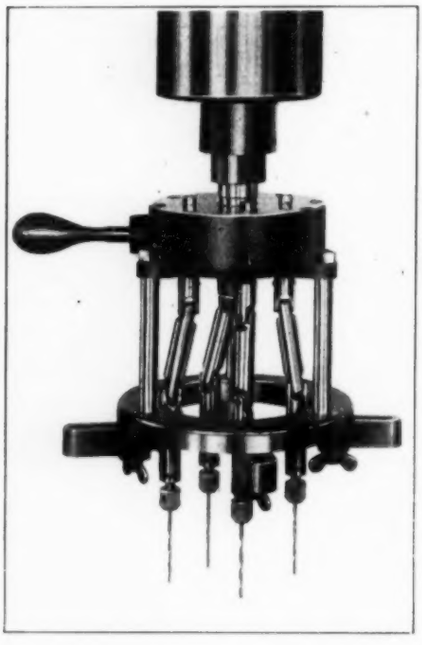
Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Multiple Drill Head

Heads can be made to carry from 2 to 10 spindles on a minimum circle of 1 inch to 12 inches maximum, and carry drills up to ⅜ inch in diameter.

This has been designed to handle a large class of work in an ordinary drill press or lathe which would otherwise require a special multiple-spindle machine. As will be seen, it consists of a taper driving shank which fits the spindle of the drill press, and in turn drives all four of the small spindles at once. These spindles can be adjusted in almost any position, and being small, can be grouped very close together if necessary. They need not be set symmetrically, but can be arranged at any point within the ring to accommodate any peculiar layout of holes. These spindles are equipped with special chucks, which will hold any drill from ¼ inch down. They require two opposite grooves



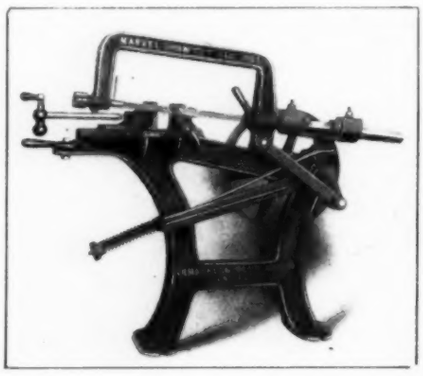
MULTIPLE-SPINDLE DRILL HEAD

on the shank of the drill, but afford a positive drive. An even wider range can be obtained by substituting a larger ring for the one shown. Lateral adjustment is provided by the upper section of the spindles being splined their whole length and driven by keys fastened in the gears.

This was designed by Frank E. Bocorselski, superintendent of the Baush Machine Tool Company, Springfield, Mass., and a patent has been applied for.

Draw-cut Hack Saw

One of the new features of this machine is the drawing cut, which does away with any tendency to buckle the saw blade, keeps the saw cut straighter, and extends the life of the blade. The blade is also lifted automatically on the return



DRAW-CUT HACK SAW

stroke by an eccentric formed on the inner portion of the crank, the eccentric rod from this extending across the machine to the spring in front. This gives a lifting motion to the saw by relieving the tension on the spring, which acts through the rod shown over the crank. On the cutting stroke this is reversed, and the saw held against the work by the tension of this same spring, which can be regulated as desired.

The handle shown projecting above the pulley and seen through the saw frame is a device for raising and lowering the whole saw. In the position shown it is at its highest point, and it will stay in any position in which it is placed. This is for raising the saw out of the cut so that any measurement desired may be taken, and by reversing this handle the saw is again set at work.

A rapid-acting vise is provided, which consists practically of a ratchet, so that the jaw can be moved back and forth to any desired position, while any finer adjustment is made by the screw. At the extreme front of the machine is a handle by which the saw frame can be locked in the forward position by the hook shown, and can be released by simply moving this handle to one side. The saw frame works on a slide made of a ⅞-inch square steel bar set on quarters, and with loose piece bearings so that all wear can be taken up. The driving shaft has bronze bearings, and the usual stock stop is provided. This machine is made by the Armstrong-Blum Manufacturing Company, Chicago, Ill.

Foot Press with Gang Dies

The Ferracute Machine Company, of Bridgeton, N. J., has recently built a special foot-press fitted with a gang of one hundred ⅝-inch punching dies for cutting that number of moist paper blanks complete at one stroke. Extreme accuracy was required in fitting the dies, it being well known that moist light-weight paper cannot be sheared unless the shearing edges are true and sharp. The alinement between upper and lower dies was perfected by means of four hardened-steel pins projecting downward from the upper die with corresponding bored holes in the lower die, on the sub-press principle.

The punches were hollow, each punch

FOOT PRESS WITH GANG DIES

containing a knockout or ejector to push the blank down through the lower die into a brass tube. These tubes were held in place by perforated plates to which they were soldered, the nest of tubes being pivoted to enable its movement away from the lower die, allowing the operator to inspect the interior of the tubes, as desired. One of the two hand levers (shown at right of press) swings down the nest of tubes from a center at rear of press and

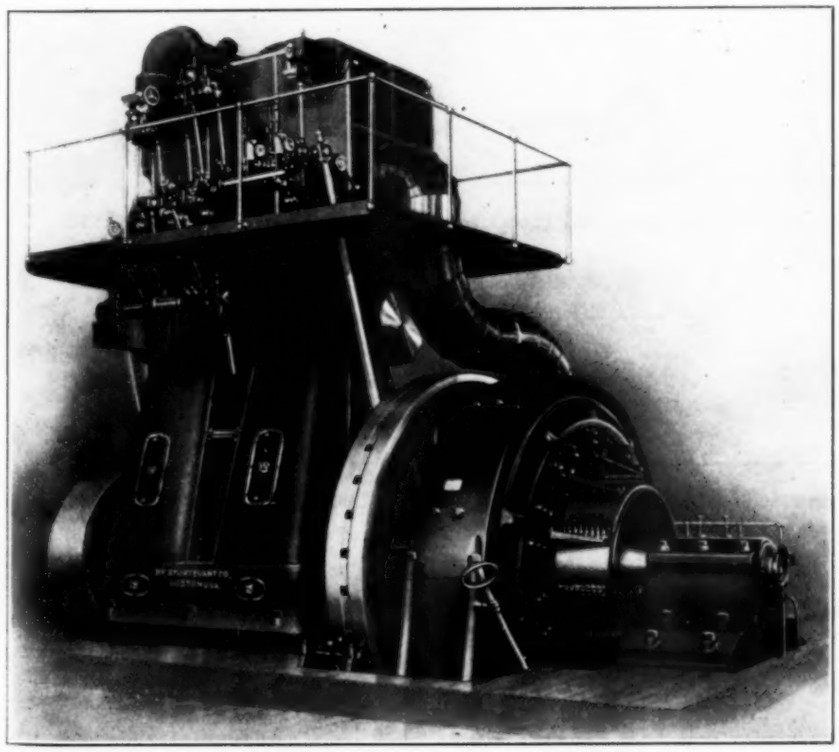
the other revolves the nest around its own axis. A counterweight at the back of press balances the tubes, enabling the operator to swing them down and replace them in position in an instant.

By means of these tubes, each blank is deposited in place in a receptacle, the legs of the press being flared so as to give the necessary room. The stripper is hinged at the back, the front end rising on the up-stroke, giving ample space between stripper and lower die for the insertion of paper sheet. If, by any mischance, friction between the dies should cause them to stick, the up-stroke of the ram may be hastened by using the sub-treadle. The stroke of the press is 4 inches and the total weight of press and dies, 2750 pounds.

Generating Sets for Light or Power

The B. F. Sturtevant Company, Hyde Park, Mass., who have been building generating sets for a number of years have recently added a number of larger sizes to their line, the one shown being a 400-kw. and consisting of a vertical compound engine and a 10-pole generator. These are four-valve engines, but instead of the rocking valve of the Corliss type, there are gridiron side valves operating in valve chambers at each corner of the cylinder casting. Although there are only four valve chambers, there are six valves, as the admission end has both a main valve and a riding cut-off, also of the gridiron type.

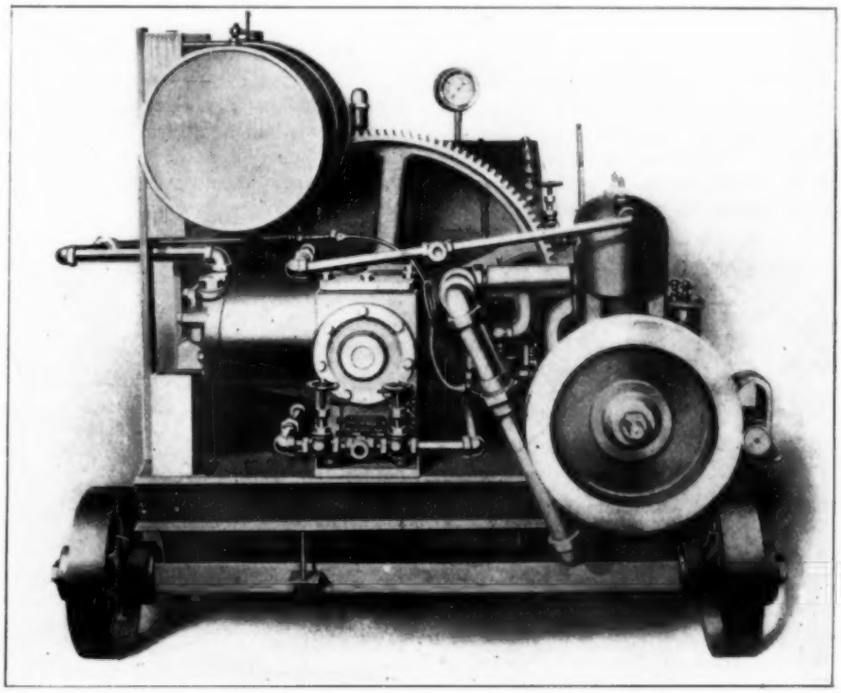
The governor is a modification of the well known Rites inertia type and is placed in a separate fly-wheel, governing within less than 2 per cent. between no load and full load. The engine is equipped with a system of forced lubrication which automatically supplies all bearings under a pressure of from 10 to 20 pounds per square inch. As will be seen, it is a very compact unit and generators of this type can be supplied in from 150 to 500 kilowatts.



GENERATING SET FOR LIGHT AND POWER

Portable Air Compressor Plant

The illustration shows a portable plant designed for use in construction work at points where no power supply of any description is available. The compressor in this plant is driven by a gasolene engine, which takes the place of the electric motor ordinarily used. All the details, it will be observed, are of standard manufacture. The plant was assembled by the Link Belt Engineering Company, of Philadelphia, to be used in connection with their own construction work.



PORTABLE AIR COMPRESSOR

It is mounted on a truck made of steel channels and partly covered with sheet iron. A water-jacketed pump is connected by gear and pinion to the engine shaft through a friction clutch. The engine is a Lackawanna two cylinder, 5-h.p., marine-type gasolene engine. Both engine and pump are water-cooled from a single supply connection, but the flow of water to each may be regulated separately by globe valves in each inlet branch. The air reservoir is 20½x36 inches, with an approximate capacity of 6 cubic feet.

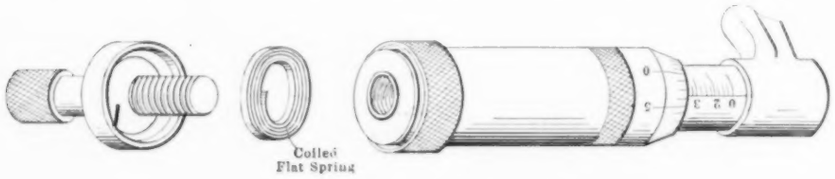
Standard Rod and Yoke Ends

The standardizing of parts that go to make up automobiles or any other machinery is always to be commended. The Billings & Spencer Company, of Hartford, have applied this to rod and yoke ends. These are drop forged and are made in accordance with the new standard adopted by the Association of Licensed Automobile Manufacturers, both as to quality of material and design. Their design is such

as will permit of the greatest possible radius of action, maximum strength with minimum weight. They are furnished either in blanks, milled or assembled. The shanks are swelled at the ends to facilitate hand welding. They also make an adjustable yoke end, also in accordance with the A. L. A. M. standards. These adjustable yoke ends can be had in blanks or milled and threaded as desired.

Friction Stop for Micrometers

A novelty in the way of ratchet or friction stops for micrometers has recently been brought out by the J. T. Slocomb Company, Providence, R. I. Instead of a ball or similar device he uses a flat spiral spring similar to a clock spring, coiled around a steel washer and fastened to it by one end being pinched in a slot in the disk as shown. This spring is of bronze and nearly fills the chamber between the washer and the outer wall of the thumb piece.

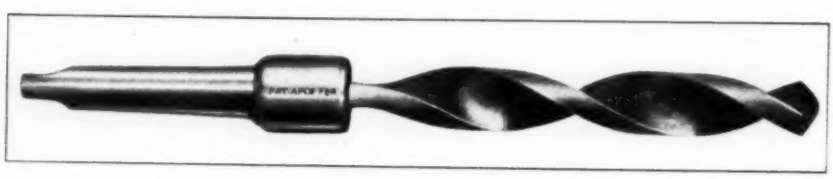


FRICTION STOP FOR MICROMETER

When turned to close the micrometer point on to a piece of work the thumb piece slips at the desired pressure, but a turn the other way opens the coil against the thumb piece and the screw starts back at once. This makes a very smooth acting friction stop and seems to have nothing to get out of order.

The Yankee Twist Drill

This is a new high-speed twist drill which is being made by Lincoln & Williams Twist Drill Company, Taunton, Mass. The drill is twisted from a flat piece of high-speed steel, and the end fitted into a slot in a soft-steel shank, which is then brazed in place. After this a steel collar is shrunk over the slotted end of the shank, inclosing the drill and making a very rigid connection. This enables it to be used in the regular drill socket the same as any drill instead of requiring a special chuck or holder.

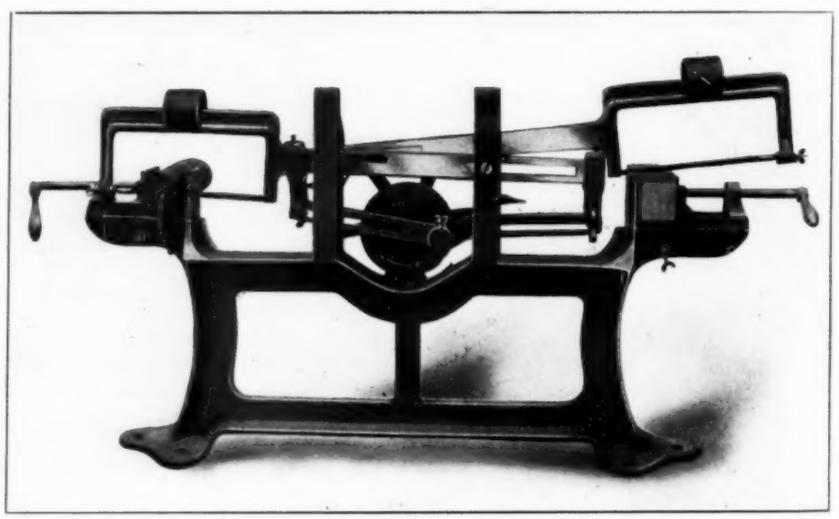


THE "YANKEE" HIGH-SPEED TWIST DRILL

A Tandem Hack-saw

This is a novelty in hack-saw construction giving two complete hack-saws in one frame and using the minimum of power as one saw is cutting while the other is on the return stroke. It has a flexible or elastic feed and both saws are provided with a lifting motion holding them out of contact with the work on the return stroke. The elastic feed accommodates itself to the density of the material being cut and is said to be very easy on saw blades.

It is provided with an automatic shut-off which stops the saw the instant it is through the cut. The vises are fitted with swivel jaws which adjust themselves to hold any shaped piece, or they may be removed entirely should it be found desirable on any particular work.

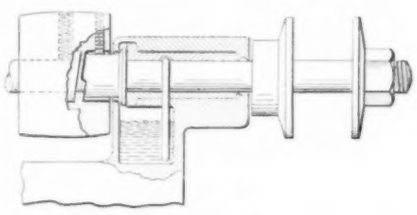


A TANDEM HACK SAW

Each saw has a capacity of 5x5 inches and a stroke of 6 inches. The floor space occupied is only 12x48 inches. The driving pulley is 14 inches in diameter by 3-inch face and affords plenty of power for running the saws at from 85 to 110 strokes per minute which is a very high speed for hack-saws. This is being made by the Buffalo Specialty Company, Buffalo, N. Y.

Cam-adjusted Bearing

The illustration shows a method of adjusting end play of bearings that is different from the ordinary. Both the hub of the driving pulley and the set collar have a cam surface on the end, the pulley being fixed to the shaft. To adjust the side set-screw is loosened and the cam turned as much as desired, it is then fastened again and a rigid lock is secured.



CAM-ADJUSTED BEARING

The oil well has a lip which projects beyond the collar of the cam sleeve so that any oil which works out is thrown into the oil well to be carried to the shaft by the oil ring. This is made by the Challenge Machine Company, Philadelphia, Penn.

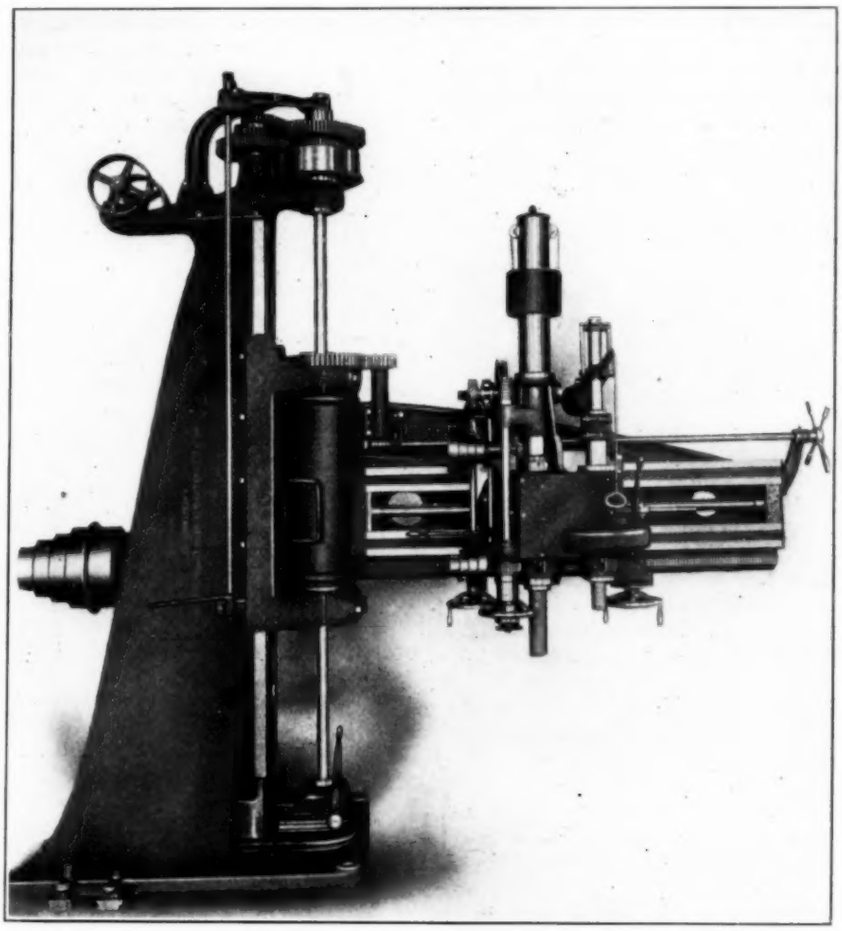
The Government mining engineer's report for the Transvaal shows that the value of machinery and plant installed in the fiscal year 1906-7 increased by about $6,500,000 in the gold-mining and allied concerns, by $85,000 in the coal-mining industry, and by $800,000 in industrial concerns.

Bolivia ranks second among the tin-producing countries. The Bureau of American Republics announces that the Bolivian exportation of tin to Europe and America in 1907 amounted to 15,300 tons.

Large German Radial Drill with Two Spindles

This drill has been designed especially for high-speed work and has a capacity in solid steel up to 2.95 inches in diameter. It differs from our own makes in having two spindles on the radial arm. The driving pulley runs on a sleeve which takes the belt strain instead of the spindle and the whole driving mechanism is well supported at the top of the column. The bringing the spindle quickly to or from the work. The tapping spindle has hand feed and runs at 80 per cent. of the boring spindle speed.

The reversing gears are operated by a lever on the right-hand side of the tapping spindle. Three turns of the hand wheel on the right-hand side of the tapping spindle brings the tapping spindle exactly in the place of the boring spindle. These three turns of the hand wheel are regulated by an adjustable index plate and spring bolt.



GERMAN RADIAL DRILL WITH TWO SPINDLES

bevel gears driving the boring spindle have a ratio of 1 to 2 while the ratio of the back gears are 1 to 5, these being operated by the lever shown on the side of the column, a quarter turn of this lever bringing the gears in or out of mesh and engaging a coupling either with the pulley or with the gears above the pulley. This coupling is keyed to the spindle while the pulley and gears are loose on it.

The radial arm swings on ball bearings and is operated by a ratchet for fine adjustment and by the cross handle for quick adjustment.

The boring and tapping spindles are both counterbalanced. The boring spindle is provided with four belt-driven feeds, has fine hand feed and hand feed for

The vertical feed of the radial arm is operated by the hand lever near the foot of the column, the feed screw being equipped with ball bearings. The head works at all angles, is turned by a worm and wormwheel and is graduated.

The drill is provided with a two-speed countershaft and has 16 spindle speeds. Diameter of the boring spindle is 3.15 inches and has a No. 5 Morse taper, the diameter of the tapping spindle is 2.36 inches and has a No. 4 Morse taper. The boring spindle has a maximum working radius of 72 inches and a minimum working radius of 18 inches.

The net weight of the machine is 13,225 pounds. It is built by H. Hessenmuller, Ludwigshafen a. Rh. Germany.

Record Performances — Universal Joints—Get-together Meetings —Fly-wheels on Countershafts

By John R. Godfrey

It often happens that when a new design of machine is being put through the first castings will come out right and be finished without any difficulty. Then all hands, the draftsman, patternmaker, molder and machinists congratulate themselves on the fine work they did.

But when the first lot comes along there is apt to be trouble. The castings may be too full or not quite clean up and the molder goes to the patternmaker to have the patterns changed a little before the next lot. It is quite natural to expect a few changes until the new design gets to running well and is often done, but if the manager stops to think about it he will not have the patterns changed before he investigates a little.

He will ask how it was that the first one went through all right when the later ones are all wrong, and he will probably find that the best molder was put on the first one, that it was given careful attention in the foundry and in the machine shop. When the lot came along it was handled by men who have less skill or less interest, and it only takes a slight lack of interest to make quite a difference in the results of a foundry or anywhere else.

All this may be perfectly natural, but the results are unsatisfactory any way we look at it. If the pattern is not near enough the right size to produce castings commercially, the foundryman should find it out on the first casting and not nurse it along as it discredits his later work. For if a pattern can be used to produce a good casting once it can the second time and the manager naturally thinks that nothing but carelessness prevents it. This is one reason why star performances or records, are double-edged swords both for the workman and for those higher up.

Universal Joints

We all know the advantages of having universal joints for shafts not exactly in line and the professors have told us of the necessity for using a pair of them to offset the irregularity of motion caused by the angularity of the shafts. Some of us may have been a little skeptical about this and laid it to the ultra-refinements of too much theory, but a recent case in a shop in New England showed the professors were right in this case anyhow.

'Twas on a good sized milling machine of one of the best makes, where the feed connection came to the table with its two universal joints. The machine was started up and a heavy feed put on when

much to the surprise of everyone the table began doing the cake walk instead of the steady dignified march of progress from one end to the other. The feed was a series of jumps just as though a ratchet were employed similar to the way in which the hands of a big clock jumps twenty or thirty seconds at a clip as the case may be.

Investigation showed that the universal joints had been put on wrong in one place so that the jaws on opposite ends of the angular shaft were at right angles instead of opposite. The spline in the angular shaft had been cut on the wrong quarter and as a result the irregularities in the revolutions came together instead of being equalized or dissipated or compensated, whichever you prefer, and was particularly objectionable when the shaft was very far out of the horizontal.

Cutting a new spline at 90 degrees from the old, fixed the machine all right and all hands had an ocular demonstration that they will be likely to remember.

Talking It Over

This same shop has made another discovering that wasn't an accident. It's a get-together-plan that goes into action every morning at 9 o'clock. The manager and the department foremen get together to talk things over for the good of the cause. Suppose there is a new lot of machines coming through. The drafting room sets a date when the drawings will be done, the patternmaker estimates how long his end of the job will take; the foundryman does his little figuring and tells when he can deliver to the machine shop, providing, of course, all the others keep to their time tables.

A note is made of these dates and then other matters are taken up, the conferences usually being brief and to the point. When the first date comes around the manager asks the draftsman if the drawings have been delivered to the patternmaker and as each delivery falls due, the report must be made. In this way it is a check on the estimating ability as well as the general capacity of each foreman and it isn't half as easy to explain a delay to the manager as it is to jolly along the foreman of the next department and it keeps each department up to the mark without any dickering between foremen. It cuts out personal controversies to a large extent as each foreman makes his own statement and he is pretty sure not to make a claim that he can't back up with facts before the court of last resort. It is simply another case of fixing responsibility, holding each department accountable for its own results, and, works out very nicely in actual practice.

Fly-wheels on Countershafts

The reversal of small planers is usually attended with more or less slippage of the narrow belts used, both from the counter to the planer and from the line shaft to the counter itself. So to steady the action of the countershaft some concerns are mounting small fly-wheels on the countershaft to help steady its running and carry things along smoothly.

And it does just what you might expect, absorbs and gives out energy just as any fly-wheel and makes a smoother running planer. Several old planer men I've talked to on the subject seem to think it's a good move, so it may be worth trying.

The Getbusyograph

In these days of wireless telegraphy we ought not to be surprised at any development of its principles and the following report to the superintendent of the Workum & Squezum Company from the inventor of the new device, will show what is being acomplished. When these get into common use we'll all have to watch out all the time.

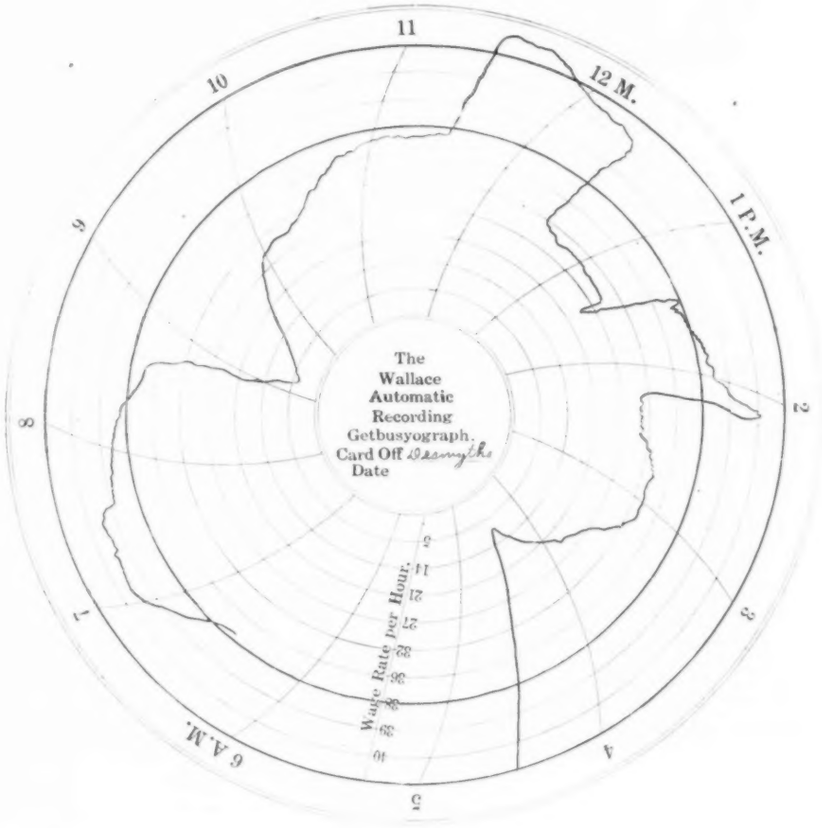
Dear Sirs:

In accordance with verbal instructions from you on a recent date I have applied the Wallace wireless automatic recording getbusyograph to your Mr. DeSmyth, and the record thus secured is hereby inclosed.

There is absolutely no reasonable doubt as to the correctness of this record of the manual and mental efforts put forth by this man, on the date named.

As you are undoubtedly aware, the getbusyograph is an instrument which is attached to a person without his knowledge, and will record all work performed by him during a certain time, and from this record one can readily ascertain whether he is earning more than he receives for his labor, or less.

By referring to the diagram or record you will notice that the radial lines divide the circumference of the hyperbolic curculium into the twelve signs of the Zodiac namely: 6 a.m. to 5 p.m. The interplanetary anticulum of the oasis represents the wage rate of the wearer as indicated by the black line about 16 degrees 35 minutes 37 seconds from the apex of the auxiliaries. Each circle upon the exterior of this three-lap track represents the aspirations of the individual, while those on the infield diverging toward the center represent the highest hopes of the boss.



THE GETBUSYOGRAPH

The irregular line of indefinite direction represents the actual work performed by the wearer, and the getbusyograph can't tell a lie. Its performance can be banked on if you hold a pair of threes. It is on the job all the time, is absolutely fool proof, non-collapsible, "A" No. 1, and bottled in bond. It's as sure as lightning, death and taxes.

You will perceive that the wearer was late getting his overalls on and for 15 minutes threw in the back gear and took a blue-chip cut out of the atmosphere, after which he felt ashamed of himself

and worked like a barrel of hard cider till 8:19 a.m. when he looked up, and seeing that the boss was over raising hail columbia happy land with an apprentice, he wiped the oozing perspiration from his noble brow with a lace handkerchief and in loud and thunderous tones thought "Oh, what's de use!" About 9:30 the fellow on the milling machine came over and approached the patient and ejaculated: "Say you mutt, wot's de matter wid yez. Take a brace! assimilate, vamose, don't ye see de head guy from de office perambulating tru de works wid de string of million bucks and de calico dolls? An de boss is wid em. Come out of yer trance! Skidoo," and the patient indifferently threw out the tailstock on the loose pulley and oiled up the belt shifter. By 11 a.m. he was earning almost as much as he got paid for up till 11:30, at which time the whistle blew.

When a hungry man hits the trail for a pie foundry no power on earth can stop him but horse-power, and then he makes an ass of himself. In this case his efforts were so strenuous that the long range cut-off approached the county line and was saved from breaking the hair spring only by the arrival of the biscuit juggler. The satisfaction of a lazy man's ravenous appetite is an operation unduly prolonged, in this case, till the cows come home. So overburdened was he that he didn't hear the one o'clock whistle blow till 12:35 p.m. and he threw the clutch on the carbureter and backed up to get a good start. Then the tool needed grinding as indicated by the slight drop in the theoretical expansion curve at 1:25. This accomplished he went back to the mines. That wavy line might be taken by the illiterate and uninitiated to be a defective spring in the radiator but it is not. That is nothing more or less than inborn desire. All men have it—at times, especially when the pocketbook comes around. Right here Mr. Joyful came through the shop with J. Spearpoint Morgan and the patient was making the chips fly to catch a raise. That was the desire as set forth by the card. The cause having departed the effect was bound to follow. Action and reaction are equal, for example: Two men on the run taking the inside track passing at the corner of a building.

The excitement having subsided, a little work was accomplished till 3:10 p.m. at which time you were up on the carpet in the office and advantage was taken of your temporary absence. At the time the whistle blew the wearer of the getbusyograph was earning just 5 cents per hour, but at the first note he grabbed his hat and coat and cut for home feeling perfectly satisfied that a day's work had been accomplished, and if he had done more he would have accomplished less.

In working out a theoretical expansion curve for this diagram I find that although the wearer was getting 38 cents per hour and asking for more, the record shows that only for an hour and twenty minutes during the day did he earn his bread and butter, for the remainder of the time, someone else had to do enough more to make up the loss.

G. H. Wallace, Inventor.

A Tapping Attachment Applied to an Acme Automatic

By A. Klein

Referring to the illustration at page 908, this tap holder, as applied to the Acme screw machine consists of a stationary spindle *A* within a revolving hollow sleeve *B*. The stationary spindle is held from turning by the key *C* at its rear end. It slides in a stationary bracket *D*, which allows the spindle to travel endwise in the hollow sleeve, and is held back by a coiled spring *E* at its rear end.

The hollow revolving sleeve is connected by means of two sliding keys *F F* to the shell at the end of the stationary spindle. This shell revolves on suitable bearings, and carries on its inside an internal gear *G* which meshes into a pair of idler pinions, thus transmitting its motion to a central pinion *H* on the tap. This pinion has at one end two hardened pins, which act as a clutch to engage two similar pins fixed into a flange *I* on the small tapping shaft. This tap is held stationary by means of another pair of pins in the rear side of the flange, and engages with two pins fixed in a disk fastened to the stationary spindle. This disk is one of the bearings on which the shell revolves, the small spindle is held in mesh with the stationary pins by means of a coiled spring *J* at its rear end.

The operation is as follows. The tap is held stationary while the work revolves; the turret carrying the tools feeding forward at the proper rate. The tap enters the work. In case the turret should travel ahead too slowly for the tap, the tap is pulled out and away from the pins which hold it from turning, thus allowing it to run free with the work and avoiding damage. When the tapping is completed and the turret backs away, the tap is pulled out and thrown in mesh with the pins on the revolving central pinion, which is turning in the same direction as the work, but at an increased speed of 3 to 1, thus backing the tap out while the work revolves. As soon as the tap is clear of the work it is drawn back into mesh with the stationary pins by the coiled spring at the rear end of the small spindle, and brought into readiness for the next piece. This fixture necessitates running the machine in a right-hand direction for a right-hand thread and *vice versa*.

The first advantage of this attachment is that it does away with the necessity of stopping the spindle. At present, it is necessary before the operation of tapping can be performed to apply the friction clutches to the spindle to stop its revolution, but with this device the spindle can rotate while the tapping is being performed. Consequently, no friction clutch gears are required. Since there are no friction clutches and gearings required the operating mechanism is simplified.

A second advantage is this: The shell through the gearing engages the tap, which is made to revolve in the same direction at a speed in this case three times as great as the work itself, and through this increased speed makes the tap come out twice as fast as it goes in. By means of this increase it becomes practicable to speed up the horizontal motion of the turret because it takes less time for the tap to come out, and we can start the next operation sooner than heretofore. Consequently the output may be increased from 25 to 40 per cent. or more, depending upon the pitch and depth of thread.

A third advantage is: In some cases it becomes necessary to perform an extra operation on the work, but this could not be done satisfactorily owing to the stoppage of the spindle. With this device it can be performed because the spindle is always revolving.

On one particular job on which this device is used, a thread 5/8 inch deep, 32 pitch, the output was increased 25 per cent.

The device is patented.

[The illustration referred to in this article inadvertently appears at page 908 of this issue.—Ed.]

Society of Automobile Engineers

The third annual meeting of the Automobile Engineers will be held in Detroit June 25-27, with the Hotel Cadillac as headquarters. The program has been arranged so that it will fit in well with the proceedings of the American Society of Mechanical Engineers' convention that is to be held in Detroit on simultaneous dates.

Robert F. Mann

Robert F. Mann, assistant superintendent of Schumacher & Boye, Cincinnati, Ohio, died on May 26. Mr. Mann came from Bathurst, N. B., and his long experience as a machinist made him well known in the machine-tool industry. He had been connected with his last firm for about 8 years.

Business Items

H. G. Barr has moved his office and machine shop from Winona and Nebraska streets to 21 Hermon street, Worcester, Mass.

The office and warehouse of Cammell, Laird and Company, agents for the Cyclops Steel and Iron Works' high speed and carbon steels, has been moved to 25 Cliff street, New York.

The new general offices and warehouses of Jos. T. Ryerson and Son, at 16th and Rockwell streets, Chicago, have been completed and occupied. The offices at Milwaukee avenue and Lake street have been vacated.

The R. D. Nuttall Company, Pittsburg, has added to its list of gears and pinions the Titan brand of manganese steel gears and pinions, having arranged with the Atha Steel Casting Company for their exclusive sale.

The Standard Roller Bearing Company, of Philadelphia, has recently installed in its factory a thoroughly equipped testing laboratory, in charge of Walter H. Hart, an expert chemist formerly connected with the Alan Wood, Iron and Steel Company.

F. S. Garrett and W. S. Quigley, formerly with the Rockwell Engineering Company, have formed a new company—the Rockwell Furnace Company—for the design and manufacture of metallurgical furnaces of all kinds, and fuel, ore and gas burning appliances. They have opened offices at 26 Cortlandt street, New York.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids as follows: June 16, motors (schedule 1296), differential blocks (schedule 1299), steel (schedule 1299), pipe and fittings (schedule 1295). June 23, electric fans (schedule 1308), motor fans (schedule 1313), gages (schedule 1313), leather packing (schedule 1313), taps and die plates (schedule 1313), twist drills (schedule 1310), hardware and tools (schedule 1313), pneumatic drill and hammers, valve reseating machine, expanding mandrels (schedule 1313), pipe and fittings (schedule 1312), pipe and fittings (schedule 1292), sensitive drill, dry grinder, oilstone grinders, water tool grinders, wood turning lathe, knife grinding machine, woodworking machine, molder, planer, planer and jointer, band saw, rip saw (schedule 1294). July 7, electric cranes (schedule 1).

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

Perfect factory space to let. Robert J. Emory & Co., Newark, N. J.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

We are equipped to turn out twice the number of gears used on our own work, can we do yours to fill in? Samuel M. Langston, Camden, N. J.

Wanted—Foundry and machine shop want orders for brass castings in quantities; also speed and monitor lathe work. Box 182, AMERICAN MACHINIST.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Have you a March 7, 1907 issue AMERICAN MACHINIST? We'll give you a month's subscription, or thirty cents, and a Steel supplement for it. AMERICAN MACHINIST, 505 Pearl street, New York.

Engineer, German-American, practical, with office at large German city, is wanting to represent first-class machine-tool builders in Germany and Austria. Can furnish A-1 references. Box 181, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists take notice. Purchase castings and blueprints of high-grade gasolene motor, of world-wide reputation and at a profitable business. Write today. F. P. Conrad, 242 Freeport St., Harrison Sq., Boston.

We are looking about for some article or articles to take over. If you have something of merit, we will take up the financing, manufacturing and sale of it on any fair basis. "H. W. D.," AMERICAN MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

A successful machine shop manager with money may before July 1 secure a substantial interest in a profitable and successful $100,000 Ohio company with fully developed and established business. Company controlled by manufacturers and business men. Correspondence invited only from men meeting requirements. Box 196, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Foreman-machinist wishes responsible position. Experienced on engines and machinery of all kinds. Excellent references. "J. R.," 190 East Ave., East Norwalk, Conn.

Wanted—Position as works manager or superintendent by man having wide experience in building machinery and interchangeable parts. Can handle men to good advantage. Best of references furnished. Box 204, AMERICAN MACHINIST.

MARYLAND

Superintendent, practical mechanic and executive, with the necessary experience to make your plant pay. Box 213, AMERICAN MACH.

MASSACHUSETTS

Experienced designer on automatic and special machinery. First-class references. Box 187, AMERICAN MACHINIST.

Designer wishes to make a change, technical graduate, five years' experience in automatic and special machinery, tools, jigs and fixtures for small interchangeable parts. First-class references. Box 195, AMERICAN MACHINIST.

Position as superintendent or manager, fifteen years' experience as superintendent on high grade work. An expert on interchangeable work, also on the most approved machine shop, foundry and boiler shop methods. Am a good organizer and can handle men and machinery to best advantage. Box 185, AM. MACH.

NEW YORK

A thorough mechanic and experienced instructor wishes position in technical school. Box 194, AMERICAN MACHINIST.

Factory superintendent with the necessary experience to deliver the goods, desires change. Box 190, AMERICAN MACHINIST.

Technical graduate, skillful and experienced in designing and constructing special and automatic machinery, desires change. Box 209, AMERICAN MACHINIST.

Superintendent or manager, twenty years' experience foundry and machine business. Mechanical and executive ability to make plant pay. Box 179, AMERICAN MACHINIST.

Responsible position wanted by expert mechanic, designer of special machinery and tools. Theoretical and practical; salary $200 per month. Box 178, AMERICAN MACHINIST.

Wanted—By first-class mechanic, well up in modern tool room and machine shop practice, position as tool room foreman or general machine shop foreman. Can furnish the best of references. Box 183, AMERICAN MACHINIST.

Tool and diemaker with fourteen years' experience wishes position as working foreman or permanent position at the bench. Can design and make working drawings. Location indifferent. Box 188, AMERICAN MACHINIST.

Superintendent or master mechanic, twenty-eight years' experience, on interchangeable work, including watch factory, typewriter, speedometer and electrical instrument work. Box 193, AMERICAN MACHINIST.

Position as factory superintendent or manager. Have had twelve years' experience as such, together with ten years of tool and machine work. First-class reference. Box 197, AMERICAN MACHINIST.

Wanted—A position as shop superintendent or assistant general manager by a graduate mechanical engineer. At present employed in a similar position by a large manufacturing plant. Will state reason, to responsible parties, for desiring to change. A-1 references. Address Box 177, AMERICAN MACHINIST.

OHIO

Mechanical engineer, graduate with thirteen years' experience in varied lines, desires position as superintendent or engineer. Am thorough shop man, good executive, and fully acquainted with modern shop methods. Was engineer for six years for firm building heavy machinery. Am young, aggressive and up-to-date. Box 207, AMERICAN MACHINIST.

PENNSYLVANIA

Toolmaker, up-to-date, used to close work, wide experience; also first-class on experiments, can handle men, wants position. Box 208, AMERICAN MACHINIST.

WISCONSIN

Position as superintendent or works' manager by a thoroughly practical man of wide manufacturing experience. Is a hustler with a forte as a cost reducer, member of A. S. M. E.—A-1 reference. Box 214 AMERICAN MACHINIST.

Experienced and thoroughly practical shop man desires position as factory manager or general superintendent. Competent to take entire charge of factory. Interchangeable manufacture. If you have need of an A-1 man who can produce results, and are willing to pay in proportion to exceptional executive ability, address Box 202, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Two draftsmen, experienced on rolling and wire-mill machinery. Must have had at least six years' experience; must be rapid and accurate. Application must state age, experience in detail, references, salary required and date available. Box 191, AMER. MACHINIST.

DISTRICT OF COLUMBIA

Wanted—Ship draftsmen. Pay $2.00 to $5.04 per diem. An examination will be held July 14, 1908, for the purpose of establishing an eligible register for ship draftsmen and assistant ship draftsmen. For application and further information address, President of the Examining Board of Ship Draftsmen, Bureau of Construction and Repair, Navy Department, Washington, D. C.

MASSACHUSETTS

Assistant instructor in woodworking and pattern making. Eastern college. Technical graduate preferred, and practical experience desirable. Salary $800. Box 206, AM. MACH.

A thoroughly reliable man to take charge of the mechanical end of a young, growing, hardware manufacturing business. This is a rare opportunity to become interested in a sure thing and dividend payer. Must invest $5,000 to $10,000. Box 203, AMERICAN MACHINIST.

Instructor in mechanical engineering. Eastern college. Technical graduate with practical experience in machine design; experience in teaching desirable. Will be required to teach machine drawing, machine design, and assist in descriptive geometry. Salary $1200. Box 205, AMERICAN MACHINIST.

MISSOURI

Wanted—Man to take charge of screw machine department, hand and automatic. Box 212, AMERICAN MACHINIST.

Superintendent for our gas engine works, able to organize a perfect shop system, get work out economically and accurately; an ordinary shop foreman or theorist will not do. Salary $1800 upwards, chance for something else. Box 211, AMERICAN MACHINIST.

NEW JERSEY

Draftsman by shop employing 100 men on wide line of light machinery. Electrical experience desirable. Address "Plainfield," AM. MA.

NEW YORK

Wanted—Experienced toolmakers; give age, references and wages expected. Box 180, AMERICAN MACHINIST.

Superintendent wanted by manufacturer of marine gasolene engines. Apply stating experience, amount of salary expected, etc., to Box 201, AMERICAN MACHINIST.

A large manufacturing company has a good opening for an ambitious young man of 20 to 25 years, who is more anxious for opportunity than present salary. He should have a fair

education and some experience in mechanical drawing, machine shop and foundry practice. Box 210, AMERICAN MACHINIST.

OHIO

Wanted—Draftsman to design machinery. Give age and experience in detail. Address Box 65, Station B, Cincinnati, Ohio.

RHODE ISLAND

Wanted—A man with an all-around repair experience to take position as master mechanic in large manufacturing establishment in New England. Experience in textile work preferred. State education, experience, age, nationality, and references. Box 174, AMERICAN MACHINIST.

UTAH

Wanted—A well trained technical and practical mechanic to take charge of a long-established shop manufacturing scientific instruments that have received the highest World's Fair awards, employing not more than twelve men Must be able to design and make or supervise the making of all kinds of fine labor-saving tools and small machines. Should also be capable of managing men and getting out work to best advantage. Also fine instrument maker wanted. State terms and experience. Box 192, AMERICAN MACHINIST.

WISCONSIN

Wanted—Six good machinists for making jigs and fixtures for automobile parts. Want one of them capable of taking charge. Open shop. Thomas B. Jeffery & Co., Kenosha, Wis.

For Sale

For Sale—Well equipped general machine shop in New Jersey; employing 15 to 20 hands; good reason for selling. P. O. Box 1216, New York City.

For Sale—One second-hand Uehling Steinbart & Company pneumatic pyrometer complete, with recording gage. Box 140, AMERICAN MACHINIST.

Alphabetical Index to Advertisers

	PAGE
Abrasive Material Co.	58
Acme Machinery Co.	71
Adams Co.	63
Almond Mfg. Co., T. R.	76
Alteneder & Son, Theo.	91
American Blower Co.	60
American Emery Wheel Wks.	58
American Gas Furnace Co.	53
American Pulley Co.	78
American School of Correspondence	90
American Tool Works Co., 8 and	90
American Tube and Stamping Co.	93
American Watch Tool Co.	74
American Wood Working Machinery Co.	70
Ames & Co., B. C.	74
Armstrong-Blum Mfg. Co.	74
Armstrong Bros. Tool Co.	57
Automatic Machine Co.	74
Baker Bros.	71
Bardons & Oliver	70
Barnes Co., W. F. & John	14
Barnett, G. & H.	36
Bath Grinder Co., Inc.	58
Baush Machine Tool Co.	3d cover
Bay State Stamping Co.	74
Beaman & Smith Co.	15 and 76
Becker-Brainard Milling Machine Co.	22
Besly & Co., Charles H.	67
Betts Machine Co.	6
Bickford Drill & Tool Co.	10
Bignall & Keeler Mfg. Co.	74
Bilgram, Hugo	84
Billings & Spencer Co.	59
Blaisdell Machinery Co.	61
Blanchard Machine Co.	69
Bliss Co., E. W.	25
Bliss Mfg. Co., E. C.	82
Blount Co., J. G.	58
Boker & Co., Hermann	1
Boston Gear Works	84
Boynton & Plummer	74
Bradford Machine Tool Co.	5
Bradley & Son, C. C.	70
Bristol Co.	4th cover
Brown & Co., R. H.	75
Brown & Sharpe Mfg. Co., 45 and	4th cover
Brown Hoisting Mchry. Co.	78
Brubaker & Bros., W. L.	58
Bullard Mach. Tool Co.	35
Burke Electric Co.	87
Burr & Son, John T.	74
C & C Electric Co.	86
Caldwell & Son Co., H. W.	84
Cammel, Laird & Co.	81
Carborundum Co.	9
Card Mf. Co., S. W.	28
Carpenter Tap & Die Co., J. M.	70
Carver File Co.	59
Case Mfg. Co.	78
Celfor Tool Co.	82
Cell Drier Machine Co.	81
Chambersburg Eng'ing Co.	71
Champion Tool Works Co.	75
Chicago Flexible Shaft Co.	93
Chicago Raw Hide Mfg. Co.	84
C. I. F. Co.	65
Cincinnati Elec. Tool Co.	86
Cincinnati Lathe & Tool Co.	83
Cincinnati Machine Tool Co.	24
Cincinnati Milling Mach. Co.	7
Cincinnati Planer Co.	14
Cincinnati Shaper Co.	94
Clark Cast Steel Cement Co.	81
Clayton Air Compressor Wks.	61
Cleveland Auto Mach. Co.	18
Cleveland Crane & Car Co.	78
Cleveland Planer Works	75
Cleveland Twist Drill Co., 4th cover	
Clough R. M.	85
Clum & Atkinson	81
Coates Clipper Mfg. Co.	69
Coes Wrench Co.	26
Colburn Machine Tool Co.	93
Consolidated Press and Tool Co.	70
Cook Co., Asa S.	91
Crescent Forgings Co.	72
Crocker-Wheeler Co.	87
Crosby Steam Gage & Valve Co.	17
Curtis & Curtis Co.	83
Cushman Chuck Co.	76
Davis Machine Co., W. P.	90
Davis, Rodney	85
Desmond-Stephan Mfg. Co.	58
Detrick & Harvey Mach. Co.	83
Diamond Chain & Mfg. Co.	79
Diamond Machine Co.	36
Diamond Saw and Stamping Works	75
Dickinson, Thos. L.	36
Dill Slotter People	66
Dixon Crucible Co., Jos.	72
Drucklieb, C.	61
Earle Gear & Mach. Co.	84
Eastern Machinery Co.	74
Eberhardt Bros. Mach. Co.	85
Elmes Engineering Works, Chas. F.	75
Errington, F. A.	77
Evans Friction Cone Co.	73
Excelsior Needle Co.	68
Farrel Fdry. & Mach. Co.	80
Fawcus Machine Co.	85
Fay Machine Tool Co.	28
Fellows Gear Shaper Co.	51
Ferracute Machine Co.	75
Firth-Sterling Steel Co.	81
Fitchburg Machine Works	29
Flather Planer Co., Mark	58
Foote-Burt Co., The	82
Fosdick Machine Tool Co.	16
Franklin Mfg. Co., H. H.	82
Franklin Portable Crane & Hoist Co.	79
Fulton Machine & Vise Co.	91
Gang Co., Wm. E.	83
Gardner Machine Co.	58
Garvin Machine Co.	85
Gem Mfg. Co.	73
General Electric Co.	86
Geometric Tool Co.	25
Gisholt Machine Co.	28
Gleason Works	4th cover
Globe Mach. & Stamp. Co.	82
Goldschmidt Thermit Co.	82
Gorton Machine Co., Geo.	71
Gould & Eberhardt	60
Graham Mfg. Co.	91
Grant Gear Works	84
Grant Mfg. & Mach. Co.	58
Gray Co., G. A.	26
Greaves, Klusman & Co.	69
Grönkvist Drill Chuck Co.	76
Hammacher, Schlemmer Co.	55
Hardinge Bros.	74
Harrison & Knight Mfg. Co.	75
Harrington, Son & Co., Edw.	79
Hart & Cooley Co.	64
Hart Mfg. Co.	67
Heller Bros. Co.	80
Hendey Machine Co.	53
Henry & Wright Mfg. Co.	65
Hill, Clarke & Co., Inc.	89
Hill Publishing Co.	62 and 92
Hisey-Wolf Machine Co.	71
Hoefer Mfg. Co.	68
Hoggson & Pettis Mfg. Co.	75
Horsburgh & Scott Co.	85
Horton & Son Co., E.	76
Hunt Co., Robt. W.	83
Hurlbut-Rogers Machine Co.	83
Hyatt Roller Bearing Co.	79
Independent Pneumatic Tool Co.	61
Industrial Oxygen Co.	81
Industrial Law League	72
Ingersoll Milling Machine Co.	68
Ingersoll-Rand Co.	61
Iroquois Machine Co.	59
Jacobs Mfg. Co.	77
Jantz & Leist Elec. Co.	87
Johnson Machine Co., Carlyle	67
Jones & Lamson Mach. Co., 12, 13 and	36
Juengst & Sons, George	65
Kearney & Trecker Co.	68
Kelly Co., R. A.	72
Kempsmith Mfg. Co.	22
Knight Mchry. Co., W. B.	73
Krieger Tool & Mfg. Co.	75
Landis Machine Co.	73
Landis Tool Co.	47
Lapointe Machine Tool Co.	72
Lea Equipment Co.	68
LeBlond Machine Tool Co., R. K.	4th cover
Link Belt Co.	60
Lodge & Shipley Machine Tool Co.	4
Long & Allstatter Co.	69
Lumen Bearing Co.	80
Lunkenheimer Co.	63
Lyon Metallic Mfg. Co.	94
Machine Screw Products Co.	73
Manning, Maxwell & Moore, Inc.	78
Manufacturing Equipment and Engineering Co.	60
Manville Bros. Co.	17
Manville Machine Co., E. J.	63
Maris Bros.	78
Marshall & Huschart Mch. Co.	89
Massachusetts Saw Works	91
McCabe, J. J.	16 and 88
Merritt, Jos.	83
Merritt & Co.	83
Metal Hardening Solution Co.	80
Milton Mfg. Co.	64
Mitts & Merrill	68
Morse Chain Co.	63
Morse Twist Drill & Mach. Co.	49
Morton Mfg. Co.	75
Mossberg Wrench Co.	79
Motch & Merryweather Machinery Co.	89
Mueller Mach. Tool Co.	69
Mummert, Wolf & Dixon Co.	75
Nash Co., Geo.	82
National-Acme Mfg. Co.	94
National Machinery Co.	74
New Britain Machine Co.	70
New Haven Mfg. Co.	64
New Process Raw Hide Co.	85
Newton Machine Tool Works, Inc.	11
Nicholson & Co., W. H.	68
Nicholson File Co.	17
Niles-Bement-Pond Co., 31, 32, 33, 34 and	88
Nolte Brass Co.	74
Northern Electrical Mfg. Co.	87
Northern Engineering Works	78
Norton Co.	57
Norton Grinding o.	56
Nuttall Co., R. D.	84
Obermayer Co., S.	80
O. K. Tool Holder Co.	83
Owen Machine Tool Co.	22
Parker Co., Chas.	91
Pawling & Harnischfeger	78
Paxson Co., J. W.	74
Philadelphia Bourse	71
Philadelphia Gear Works	84
Phosphor Bronze Smelting Co.	80
Pittsburg Auto. Vise & Tool Co., Ltd.	91
Potter & Johnston Mach. Co., 20 and	21
Powell Tool Co.	83
Pratt Chuck Co.	76
Pratt & Whitney Co.	2 and 3
Prentice Bros. Co.	27
Prentiss Tool & Supply Co.	88
Q. C. Machine Tool Co.	75
Reed Co., F. E.	49
Reed Mfg. Co.	91
Reichhelm & Co., E. P.	69
Reynolds Machine Co.	90
Rivett Lathe Mfg. Co.	3d cover
Rockford Drilling Mach. Co.	56
Rock Island Tool Co.	91
Rockwood Mfg. Co.	78
Rogers & Hubbard Co.	80
Rogers Wks., John M.	71
Root Co., C. J.	91
Roth Bros. & Co.	86
Safety Emery Wheel Co.	59
Saunders Sons, D.	72
Sawyer Gear Wks.	84
Schieren Co., Chas. A.	73
Schmitz, August	72
Schuchardt & Schutte	94
Schumacher & Boye	9
Sebastian Lathe Co.	25
Sellers & Co., Inc., Wm.	30
Seneca Falls Mfg. Co.	66
Shelby (National Tube Co.)	80
Shepard Electric Crane and Hoist Co.	79
Shultz Belting Co.	74
Sibley Mch. Tool Co.	69
Simonds Mfg. Co.	74 and 75
Skinner Chuck Co.	76
Slate Machine Co., Dwight	70
Sloan & Chace Mfg. Co., Ltd.	47
Slocomb Co., J. T.	73
Smith, Chas. F.	83
Smith Countershaft Co.	29
Smith & Mills	83
Smith Co., Wm. J.	66
Spacke Mach. Co., F. W.	61
Springfield Mach. Tool Co.	15
Standard Connecting Rod Co.	90
Standard Engineering Wks.	75
Standard Gauge Steel Co.	93
Standard Tool Co.	66
Stark Tool Co.	83
Starrett Co., L. S.	51
Stoever Fdry. & Mfg. Co.	68
Straley & Hasbrouck	82
Sturtevant Co., B. F.	24
Tabor Mfg. Co.	70
Tate, Jones & Co.	64
Taylor & Fenn Co.	69
Taylor-Wilson Mfg. Co.	85
Technical Supply Co.	91
Toomey, Frank	90
Triumph Electric Co.	90
Trump Bros. Machine Co.	75
Tudor Mfg. Co.	93
Union Twist Drill Co.	55
Universal Machine Screw Co.	65
U. S. Electrical Tool Co.	87
Van Dorn & Dutton Co.	85
Van Dorn Elec. & Mfg. Co.	90
Vandyck Churchill Co.	67
Vitrified Wheel Co.	58
Von Wyck Mach. Tool Co.	74
Wagner Elec. Mfg. Co.	87
Walcott & Wood Mach. Tool Co.	75
Waltham Watch Tool Co.	90
Ward & Sons, Edgar T.	80
Warner & Swasey Co.	92
Warner Instrument Co.	73
Waterbury Farrel Fdry. & Mach. Co.	72
Watson-Stillman Co.	57
Westcott Chuck Co.	77
Western Electric Co.	87
West Haven Mfg. Co.	58
Westmacott Gas Furnace Co.	91
Whitcomb-Blaisdell Machine Tool Co.	19
Whitman & Barnes Mfg. Co.	56
Whitney Mfg. Co.	43
Whiton Machine Co., D. E.	76
Wiley & Russell Mfg. Co.	71
Williams & Co., J. H.	82
Williamson Vise Co.	91
Wilmarth & Morman Co.	58
Woodward & Powell Planer Co.	83
Worcester Machine Screw Co.	83
Wormer Machinery Co., C. C.	90
Yale & Towne Mfg. Co.	79

Classified Index to Articles Advertised

Abrasive Materials
Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I
Carborundum Co., Niagara Falls, N. Y.
Dickinson, Thos. L., New York.
Norton Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Agents, Foreign Machinery
C. I. F. Co., New York.

Air Lifts
Ingersoll-Rand Co., New York.

Alundum
See Grinding Wheels.

Arbor Presses
Barnes Co., W. F. & John, Rockford, Ill.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Balancing Ways
Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling
Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring
Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller
Boston Gear Works, Norfolk Downs Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Iriquois Mach. Co., Providence, R. I.

Belt Dressing
Cling-Surface Mfg. Co., Buffalo, N Y.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners
Bristol Co., Waterbury, Conn.

Belt Filler
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine
Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters
The L. & D. Co., Boston, Mass.

Belting, Leather
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Benches, Work
Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machines, Plate
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machines, Power
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand
Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Blocks, Chains
See Hoists, Hand.

Blocks, Die
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Blowers
American Blower Co., Detroit, Mich.
American Gas Furnace Co., New York,
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Bolt and Nut Machinery
Acme Mchry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manville Mach. Co., E. J., Waterbury, Conn.
McCabe, J. J., New York.
Milton Mfg. Co., Milton, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National-Acme Mfg. Co., Cleveland, O.
National Machinery Co., Tiffin, O.
Newton Machine Tool Wks., Inc., Phila., Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads
Lang & Co., G. R., Meadville, Pa.

Bolts and Nuts
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Technical
American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
Sames, Chas. M., Jersey City, N. J.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical
American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago Ill.

Boxes, Tote
Lyon Metallic Mfg. Co., Aurora, Ill.

Box Tools, Roughing
Bardons & Oliver, Cleveland, O

Brazing
Industrial Oxygen Co., New York.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers
Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels.

Carborundum Paper and Cloth
Carborundum Co., Niagara Falls, N. Y.

Case-Hardening
American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Castings, Brass and Bronze
Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Berry & Parker, Erie, Pa.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Frdy. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Taylor & Fenn Co., Hartford, Ct.

Castings, Steel
Birdsboro Steel Fdry. & Mach Co., Birdsboro, Mass.
Cammel, Laird & Co., New York.

Cast Iron Brazing
Industrial Oxygen Co., New York.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer & Co., S., Cincinnati, O.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Fay & Scott, Dexter, Me.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Celfor Tool Co., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Lancaster Knife and Machine Wks., Lancaster, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn

Chucks, Drill—*Continued.*
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Westcott Chuck Co., Oneida, N. Y.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N Y.

Clocks, Watchman's
Hardinge Bros., Chicago, Ill.

Clutches, Friction
Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., W. H., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Williams Foundry & Machine Co., Akron, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Compound, Core
Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Machine Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Mach. Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Motor
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Revolution
Root Co., C. J., Bristol, Conn.
Schuchardt & Schutte, New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O
McCabe, J. J., New York.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Couplings
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Couplings—*Continued.*
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Williams Fdry. & Mach. Co., Akron, Ohio.

Cranes
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bliss Mfg. Co., E. C., Providence, R. I.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M.; Gloucester City, N. J.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co, Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Wks., Inc., Philadelphia, Pa.
Pratt & Whitney Co, Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
Krieger Tool & Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools
American Emery Wheel Co., Providence, R. I.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, O.
Manville Bros. Co., Waterbury, Conn.
Toledo Machine & Tool Co., Toledo, Ohio.

Dies, Sub-Press
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.
Technical Supply Co. Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford Ill.
Boynton & Plummer, Worcester Mass.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler
American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.

Drilling Machines, Multiple Spindle—*Continued.*

Hardinge Bros., Chicago, Ill.
Harrington Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschardt Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Works Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Kilbert Mach. Co., Cincinnati, Ohio.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co, Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Rail

Foote-Burt Co., Cleveland, O.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Standard Tool Co., Cleveland, O.

Drilling Machines, Turret

Fay Machine Tool Co., Phila., Pa.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Celfor Tool Co., Chicago, Ill.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Mach. Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.

Drilling Machines, Upright —*Continued.*

McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co, Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Electric

Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Independent Pneumatic Tool Co., Chicago, Ill.
Van Dorn Elec. Mfg. Co., Cleveland, Ohio.

Drills, Flat

Celfor Tool Co., Chicago, Ill.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Boker & Co., Hermann, New York.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cincinnati, O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, O.
Van Dorn Elec. & Mfg. Co., Cleveland, Ohio.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa

Electrically Driven Tools and Machinery

American Tool Works Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Van Dorn Elec. & Mfg. Co., Cleveland, Ohio.
Western Electric Co., Chicago, Ill.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-Room

Hart & Cooley Co., New Britain, Conn.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical

Crocker-Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Engines, Steam

American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition, Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Export

C. I. F. Co., New York.

Eyelet Machinery

Manville Bros. Co., Waterbury, Conn.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

American Blower Co., Detroit, Mich.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.

Files and Rasps

Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Heller Bros. Co., Newark, N. J.
Nash Co., Geo., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

Filing Machines

Henry & Wright Mfg. Co., Hartford, Conn.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Philadelphia, Pa.

Fittings, Iron

National Tube Co., Pittsburg, Pa.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Steel

Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Tindel-Morris Co., Eddystone, Pa.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Frictions, Paper and Iron

Rockwood Mfg. Co., Indianapolis, Ind.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Co., Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

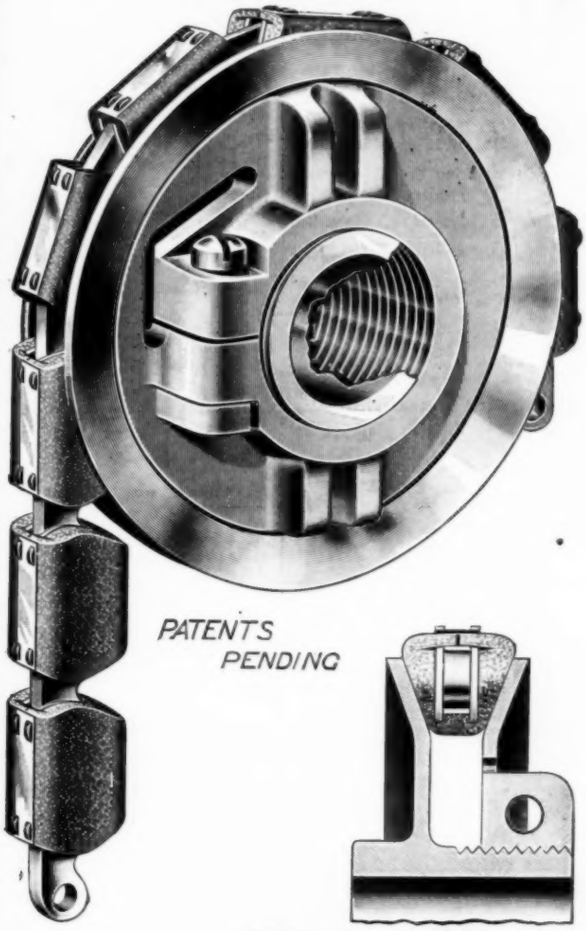
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

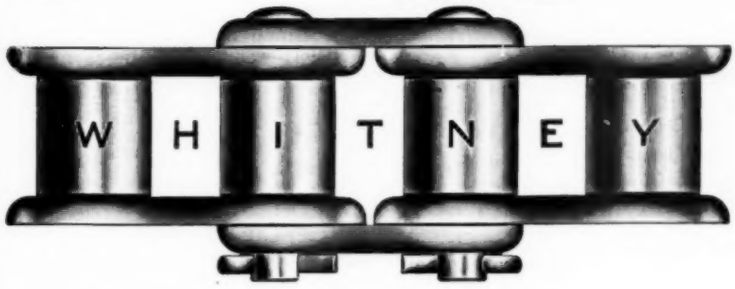
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

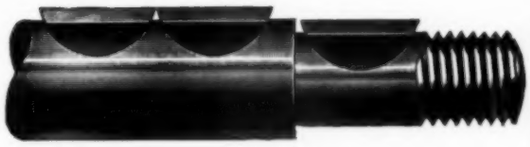
New "Whitney" Chain Belt

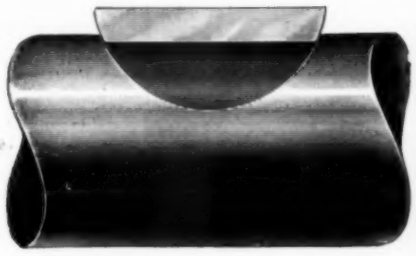
For Cooling Fans, Oiling Devices, Motorcycles, Etc.



PATENTS PENDING







If you are not taking advantage of the Woodruff Patent System of Keying it will pay you to investigate.

Better results and a great saving in cost.

We carry 95 regular sizes of Keys and Cutters in stock for immediate delivery.

"Whitney" Patent Cotter Detachable Roller Chains

Made a fine record in the Briarcliff Road Race.

THE WHITNEY MFG. COMPANY,
Hartford, Conn.

New York City, May 2, 1908.

Gentlemen—The uniform strength of an automobile driving chain is one of the important requisites in a speed contest.

The "Whitney" Chains which formed a part of the equipment on our three "Stearns" Cars in the recent Briarcliff Stock Car Road Race, showed their superiority by coming through this exceptionally difficult contest without the slightest evidence of the terrific strain which they had undergone. Our "Stearns" Cars made an exceptional showing in this race, and we attribute our success in no small degree to the entire absence of chain trouble.

Our experience in previous contests has taught us that a faulty chain can cause a lot of trouble. We therefore take this opportunity to express the satisfaction which we feel at the manner in which "Whitney" Chains demonstrated their worth.

Yours very truly,
WYCKOFF, CHURCH & PARTRIDGE,
By C F. Wyckoff, President.

THE WHITNEY MFG. COMPANY, Hartford, Conn.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording

Bristol Co., Waterbury, Conn

Gages, Standard

Ames & Co., B. C., Waltham, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam

Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Buffalo Gear & Pattern Works, Buffalo, N. Y.
Cincinnati Shaper Co., Cincinnati, Ohio.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Morse Williams & Co., Philadelphia, Pa.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Van Dorn & Dutton Co., Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waltham Machine Works, Waltham, Mass.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Buffalo Gear & Pattern Works., Buffalo, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.

Gears, Cut —*Continued.*

Gleason Works, Rochester, Mass.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.
Van Dorn & Dutton Co., Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, O.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cutter

Bath Grinder Co., Inc., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
McCabe, J. J., New York.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disc

Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Diamond Machine Co., Providence, R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Iroquois Mach. Co., Providence, R. I.
Safety Emery Wheel Co., Springfield, Mass.
Taylor & Fenn Co., Hartford, Conn.

Grinders, Drill

Heald Mach. Co., Worcester, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Safety Emery Wheel Co., Springfield, Ohio.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Iroquois Mach. Co., Providence, R. I.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Knife

American Wood Working Mchy. Co., Rochester, N. Y.
Safety Emery Wheel Co., Springfield, O.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
U. S. Electrical Co., Cincinnati, Ohio.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.

Grinders, Tool —*Continued.*

Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Diamond Machine Co., Providence, R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Iroquois Mach. Co., Prov., R. I.
Landis Tool Co., Waynesboro, Pa.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery

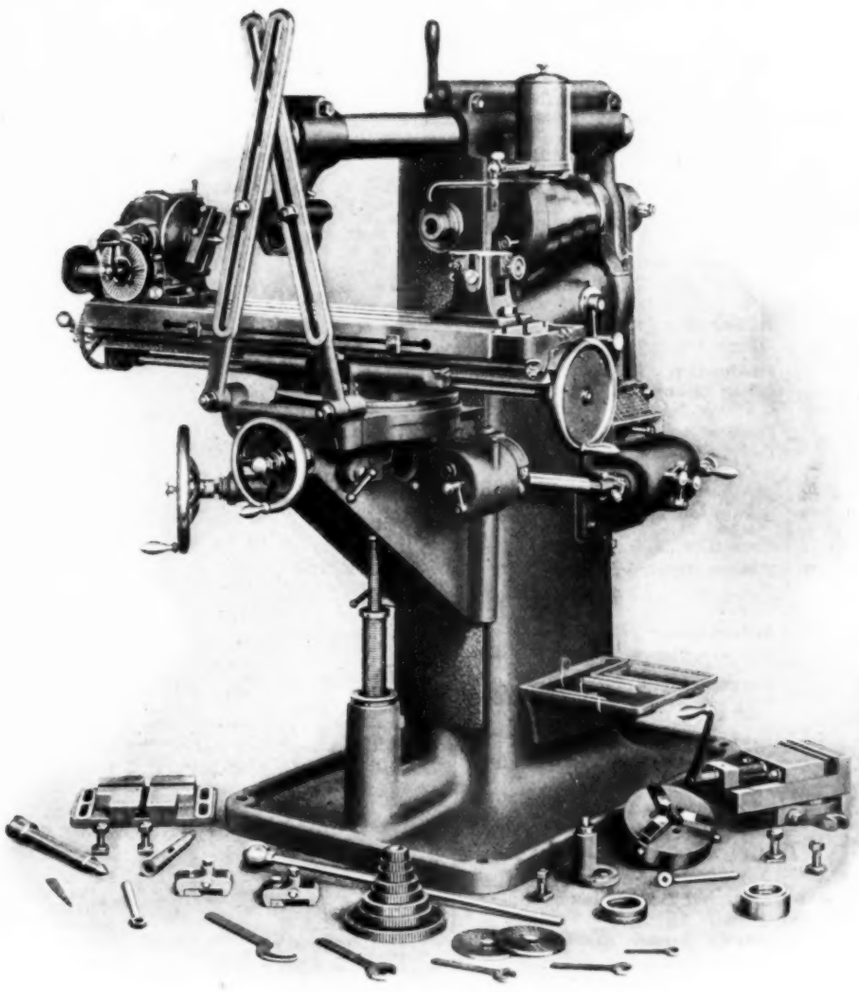
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Machine Co., Providence, R. I.
Gardner Mach. Co., Beloit, Mich.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Iroquois Mach. Co., Providence, R. I.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Prentiss Tool & Supply Co., New York.
Roth Bros. & Co., Chicago, Ill.
Safety Emery Wheel Co., Springfield, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.

Grinding Wheels

Abrasive Material Co., Philadelphia, Pa.
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Diamond Machine Co., Providence, R. I.
Dickinson, Thos. L., New York.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.



Quality of the Finished Product is the first consideration in the design of all

B. & S. UNIVERSAL MILLING MACHINES.

While it is important many times to know the capacity of a machine and how rapidly it will turn out work, it is the QUALITY of the work that has to stand inspection.

Circulars, describing any of the B. & S. Milling Machines, will be sent to any address upon application.

Grinding Wheels—*Continued.*
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grindstones and Frames
Cleveland Stone Co., Cleveland, O.
Niles-Bement-Pond Co., New York
Norton Co., Worcester, Mass.

Gun Barrel Machinery
Diamond Machine Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.

Hammers, Drop
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Iroquois Mach. Co., Providence, R. I.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Bliss Co., E. W., Brooklyn, N. Y.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Hammers, Steam
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Hardening and Tempering Process
Bliss Mfg. Co., E. C., Providence, R. I.
Metal Hardening Solution Co., Rochester, N. Y.

Heading Machinery, Cold
Manville Mach. Co., E. J., Waterbury, Conn.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Newton Machine Tool Wks., Inc., Phila., Pa.
Pratt & Whitney Co., Hartford, Ct.
Schuchardt & Schutte, New York.

Hoisting and Conveying Machinery
Brown Hoisting Machinery Co., Cleveland, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Yale & Towne Mfg. Co., New York.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.

Hoists, Electric—*Continued.*
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Hones
Carborundum Co., Niagara Falls, N. Y.

Hose, Air
Independent Pneumatic Tool Co., Chicago, Ill.

Igniters, Gas Engine
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed
Warner Instrument Co., Beloit, Wis.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston, Mass.

Indicators, Test
Boulet's Fine Tool Wks, Beverly, Mass.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Norton Grinding Co., Worcester, Mass.
Starrett Co., L. S., Athol, Mass.

Industrial Engineers
Woods & Co., Clinton E., Brooklyn, N. Y.

Injectors
Desmond-Stephan Mfg. Co., Urbana, O.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Inspection and Tests
Hunt Co., Robert W., Chicago, Ill.

Iron Bar
Milton Mfg. Co., Milton, Pa.

Jacks, Hydraulic
Watson-Stillman Co., New York.

Jacks, Planer
Armstrong Bros. Tool Co., Chicago, Ill.

Jacks, Lever and Screw
Watson-Stillman Co., New York.

Kettles, Soda
Brown & Sharpe Mfg. Co., Providence, R. I.
Mfg. Equip. & Engineering Co., Boston, Mass.

Key Seaters
Baker Bros., Toledo, O.
Burr & Sons, John T., Brooklyn, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Lapointe Mach. Tool Co., Hudson, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Morton Manufacturing Co., Muskegon Heights, Mich
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Whitney Mfg. Co., Hartford, Conn.

Keys, Machine
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Conn.

Knives, Machine
Coes Wrench Co., Worcester, Mass.
Lancaster Knife and Mach. Wks., Lancaster, N. Y.
Simonds File Co., Fitchburg, Mass.

Lamps, Arc
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lathe Attachments
American Tool Works Co., Cin., O.
Bradford Machine Tool Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
LeBlond Machine Tool Co., R. K., Cincinnati, Ohio.
Mossberg Wrench Co., Central Falls, N. Y.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Lathe Dogs
Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Tindel Morris Co., Eddystone, Pa.
Williams & Co., J. H., Brooklyn, N. Y.

Lathes
American Tool Works Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, Rockford, Ill.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cincin., O.
Bridgeford Mach. Tool Works, Rochester, N. Y.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Cincinnati Lathe and Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Dreses Mach. Tool Co., Cin., O.
Fay Mach. Tool Co., Phila., Pa.
Fay & Scott, Dexter, Me.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Kulsman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., F. E., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mach. Tool Co., Springfield, O.
Tindel-Morris Co., Eddystone, Pa.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Lathes, Automatic Screw-Threading
Automatic Machine Co., Bridgeport, Conn.
Fay Machine Tool Co., Phila., Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Lathes, Bench
American Watch Tool Co., Waltham, Mass.
Ames & Co., B. C., Waltham, Mass.

Lathes, Bench—*Continued.*
Blount Co., J. G., Everett, Mass.
Hardinge Bros., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Waltham Machine Works, Waltham, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring
American Wood Working Mchry. Co., Rochester, N. Y.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Lathes, Brass
Bardons & Oliver, Cleveland, O.
Dreses Mach. Tool Co., Cincin., O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, O.

Lathes, Extension
Harrington & Sons Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power
Barnes Co., W. F. & Jno., Rockford, Ill
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Gap
American Tool Wks. Co., Cin., O.
Harrington & Sons Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sebastian Lathe Co., Cincin., O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Portable
Lodge & Shipley Machine Tool Co., Cincinnati, O.

Lathes, Speed
Blount Co., J. G., Everett, Mass.
Chicago Machine Tool Co., Chicago, Ill.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Wood
American Wood Working Mchy. Co., Rochester, N. Y.
Barnes Co., W. F. & John, Rockford, Ill.
Prentiss Tool & Supply Co., New York.

Levels
Starrett Co., L. S., Athol, Mass.

Lockers, Clothes
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Merritt & Co., Philadelphia, Pa.
Manufacturing Equipment & Engineering Co., Boston, Mass.

Lubricants
Besly & Co., Chas. H., Chicago, Ill.
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Besly & Co., Chas. H., Chicago, Ill
Gem Mfg Co., Pittsburg, Pa.

Machinery Dealers
Besly & Co., Chas. H., Chicago, Ill.
Garvin Mach. Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Lea Equipment Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry Co., Chicago, Ill.
McCabe, J. J., New York